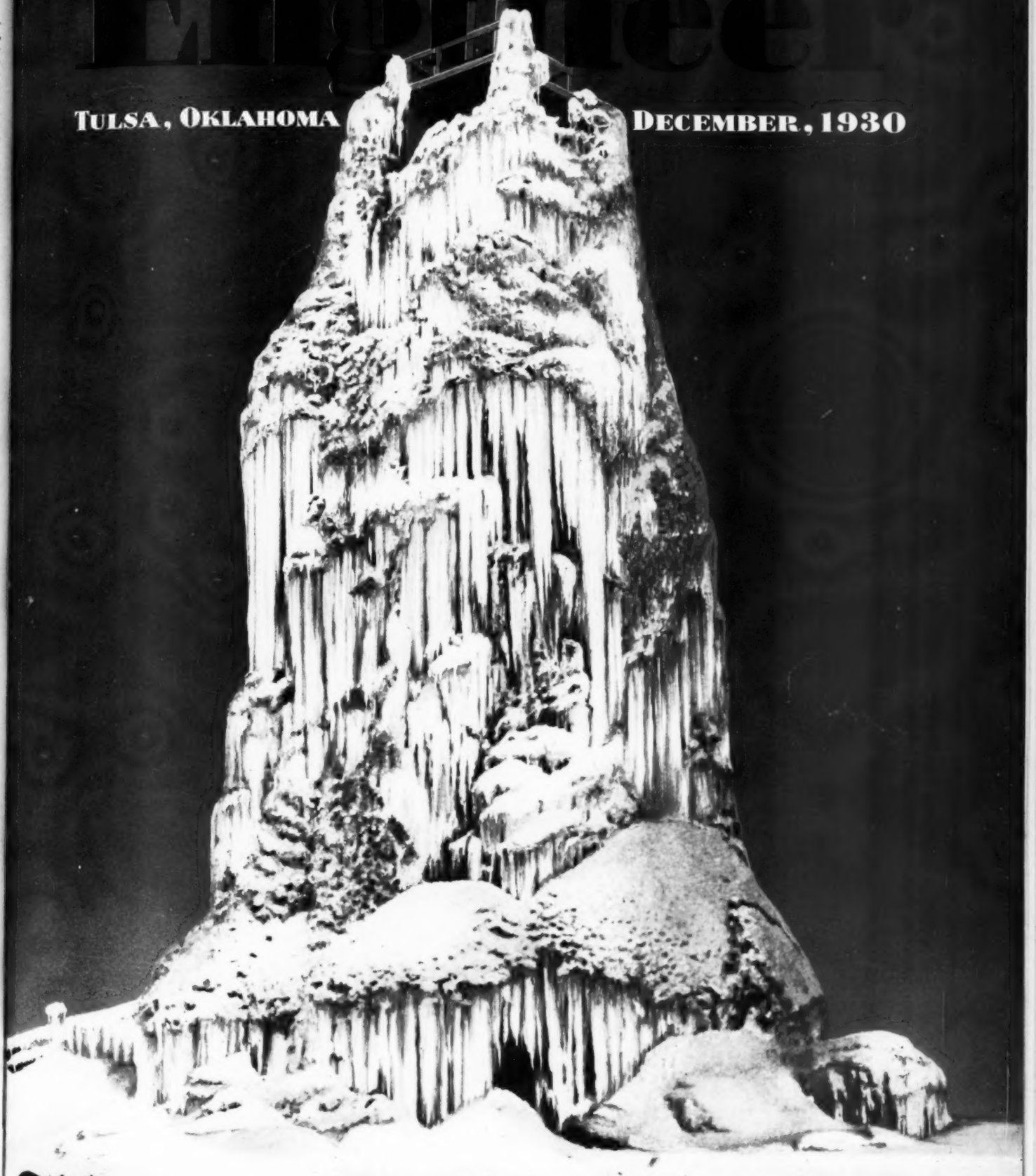
THE Petroleum Engineer

TULSA, OKLAHOMA DECEMBER, 1930



Merry Christmas

The Sharples Process

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The Processes of Contact Filtration

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The Gyro Process
of
Vapor Phase Cracking

—

The Samplitt

—

The Mixitt

Petroleum Engineer

The Engineering Magazine of the Oil and Gas Industry

Edited and Circulated Only for Those Actively Engaged in the Operating Departments of the Industry

Volume 2 DECEMBER, 1930 Number 3

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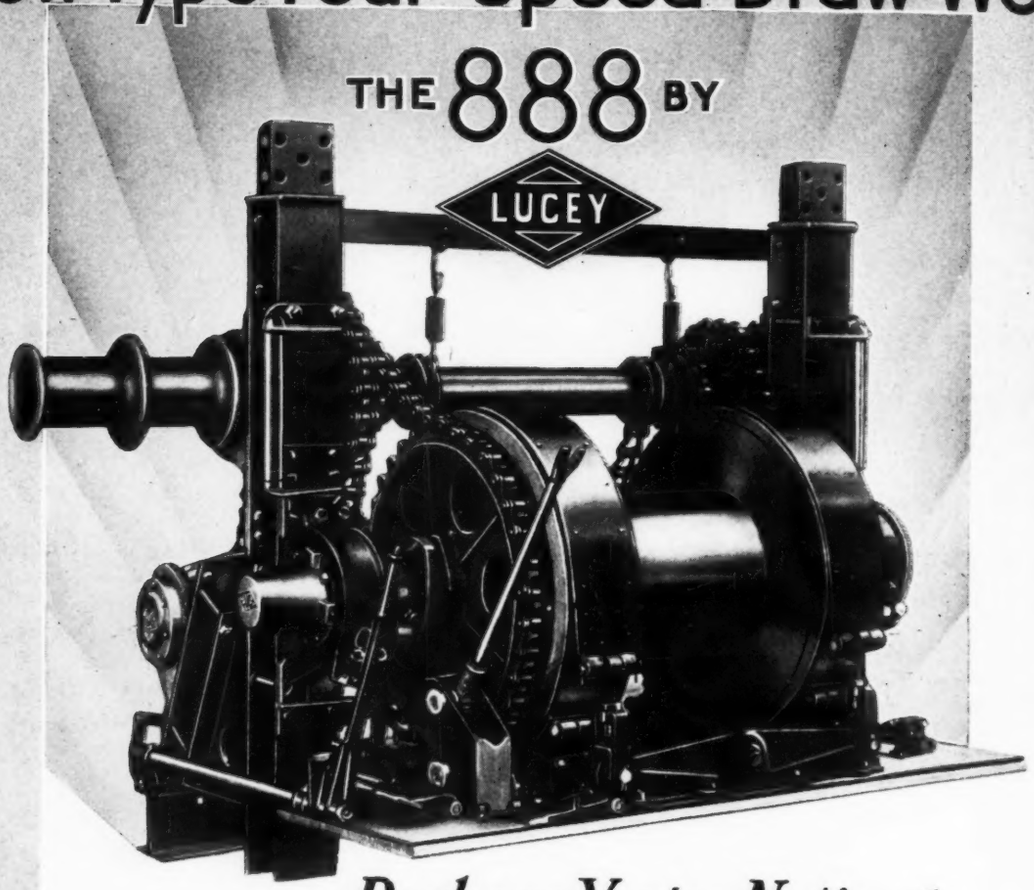
THE 888 BY LUCEY



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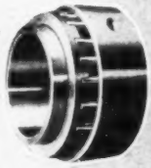

AMERICAN HEAVY DUTY ROLLER BEARINGS

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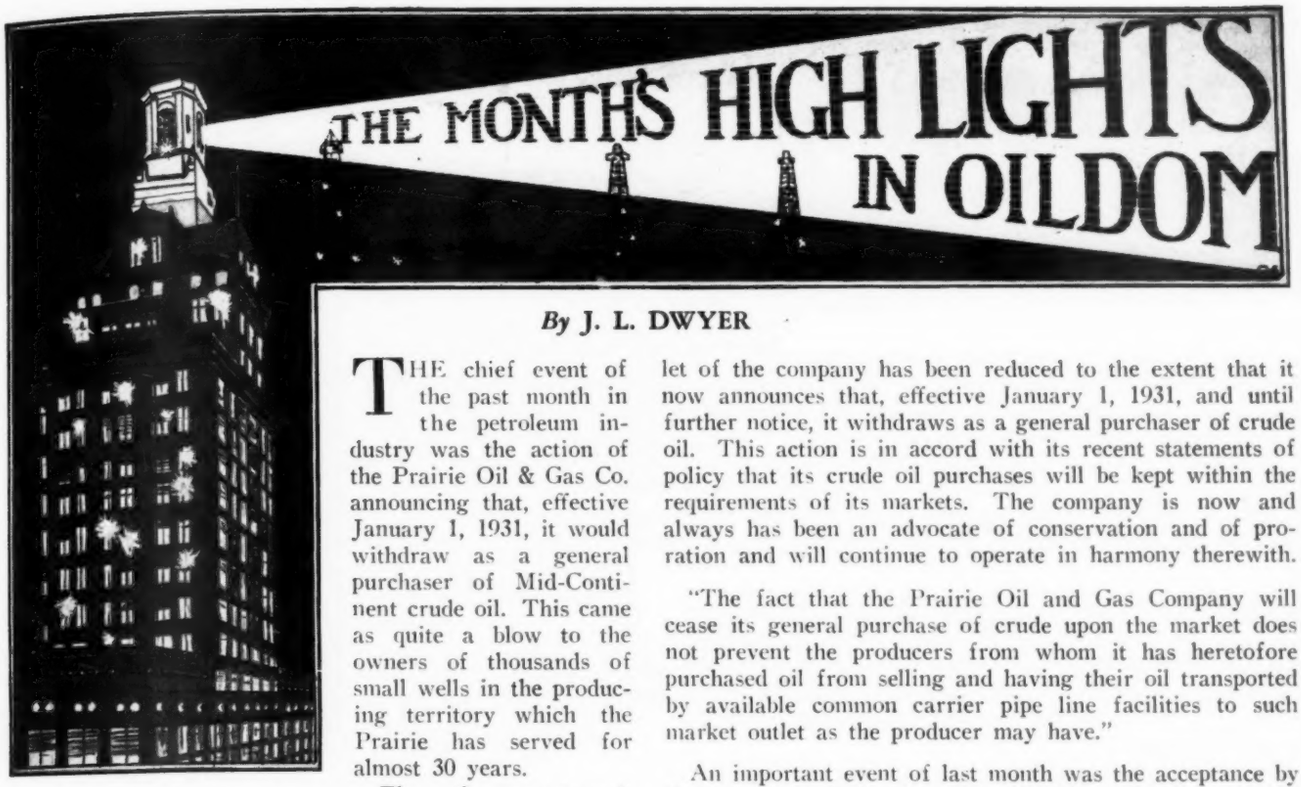


By **J. L. DWYER**

THE chief event of the past month in the petroleum industry was the action of the Prairie Oil & Gas Co. announcing that, effective January 1, 1931, it would withdraw as a general purchaser of Mid-Continent crude oil. This came as quite a blow to the owners of thousands of small wells in the producing territory which the Prairie has served for almost 30 years.

The action was necessitated by changing conditions in the Mid-Continent region and the fact that some competitive pipe lines have been built during the past year. The action of the Prairie will affect 60,000 barrels of crude oil daily which must find some other outlet. It is entirely possible that the near future may again see the Prairie company as a general purchaser. It will probably realign itself as a complete unit in the industry.

The official statement of the Prairie follows:

"For years the Prairie Oil and Gas Company as a crude oil purchaser has given its best efforts to obtaining and holding market outlets for its crude oil purchases. For the protection of its producing and refining customers it has, from time to time, increased its oil in stock when its market outlet did not equal its purchases. The market outlet of the company has been reduced to the extent that it now announces that, effective January 1, 1931, and until further notice, it withdraws as a general purchaser of crude oil. This action is in accord with its recent statements of policy that its crude oil purchases will be kept within the requirements of its markets. The company is now and always has been an advocate of conservation and of proration and will continue to operate in harmony therewith.

"The fact that the Prairie Oil and Gas Company will cease its general purchase of crude upon the market does not prevent the producers from whom it has heretofore purchased oil from selling and having their oil transported by available common carrier pipe line facilities to such market outlet as the producer may have."

An important event of last month was the acceptance by the members of the American Petroleum Institute of the report of the special committee on the economic situation in the industry. This committee, after a very thorough survey of the industry's position, recommended that all refinery runs be decreased eight per cent over the winter months in order that we enter the spring gasoline market with stocks which would not be cumbersome. In accordance with this program, refinery runs are being reduced to the required figure.

An interesting sidelight which developed during the month was the announcement of the Association of Railway Executives that this body would seek legislative action in Congress which would compel the oil companies to divest themselves of the network of pipe lines which thread the country. It is believed that this action seeks to discourage construction of future gasoline and oil lines.

* * *

Production and Refining Figures Furnished by the American Petroleum Institute

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending November 29, 1930

(Figures in Barrels of 42 Gallons)

DISTRICT	Per Cent Potential Capacity Reporting	Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Gasoline Stocks	Gas and Fuel Oil Stocks
East Coast	100.0	3,006,000	70.1	5,343,000	11,566,000
Appalachian	93.8	499,000	53.8	766,000	1,029,000
Ind., Ill., Ky.	97.5	1,803,000	67.6	4,270,000	3,914,000
Okla., Kan., Mo.	89.4	1,807,000	62.6	2,108,000	4,603,000
Texas	91.9	3,692,000	70.9	6,393,000	10,730,000
Louisiana, Arkansas	98.3	1,037,000	56.5	1,253,000	2,138 000
Rocky Mountain	93.1	317,000	32.4	1,509,000	1,017,000
California	98.8	3,875,000	62.4	14,890,000	104,257,000
Total Wk. Nov. 22	95.7	16,036,000	64.1	36,532,000	139,254,000
Total Wk. Nov. 15	95.7	16,049,000	64.2	37,263,000	139,799,000
The Texas and Louisiana Gulf Coastal figures shown below are included above in the totals of their respective districts.					
Texas Gulf Coast	100.0	2,847,000	76.8	5,149,000	8,000,000
Louisiana Gulf Cst.	100.0	713,000	69.1	986,000	1,173,000

Daily Average Production

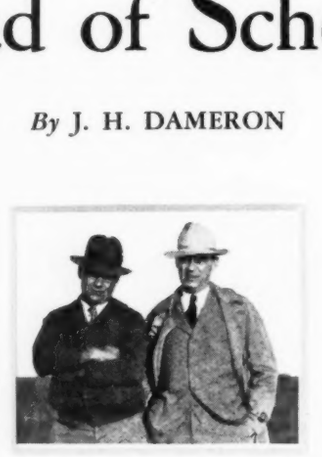
(Figures in Barrels)

	Nov. 29, 1930	Oct. 22, 1930	Nov. 23, 1929
Oklahoma	506,350	545,600	643,050
Kansas	111,700	112,650	110,650
Panhandle Texas	74,850	80,900	102,600
North Texas	63,750	62,800	89,300
West Central Texas	42,300	47,650	56,850
West Texas	266,100	273,700	357,250
East Central Texas	40,700	42,000	17,350
Southwest Texas	93,650	96,900	74,650
North Louisiana	44,050	42,150	36,450
Arkansas	51,950	52,850	63,950
Coastal Texas	162,400	167,800	148,350
Coastal Louisiana	26,550	27,850	23,300
Eastern (not including Mich.)	110,000	115,500	118,900
Michigan	7,300	7,400	15,000
Wyoming	46,900	48 850	52,500
Montana	4,950	7,900	10,500
Colorado	4,200	4,100	5,100
New Mexico	45,050	46,550	8,000
California	601,800	587,600	699,500
Total	2,304,550	2,370,750	2,633,250

Ajax Pipe Line Completed Ahead of Schedule

By J. H. DAMERON

INTRODUCING a new method of handling material along with an effective maintenance program and aided by excellent weather, the Oklahoma Contracting Company, builders of the Ajax Pipe Line Company's 400-mile double 10-inch welded oil carrier from Glenn Pool, Oklahoma, to Wood River, Illinois, made an impressive construction record by building the 800 miles of line in five months and ten days. This record is all the more impressive when it is considered construction was delayed at the start, spragged later by labor troubles and the ditching crews had to blast 65 per cent of the right-of-way before the big machines could cut the trenches.



Bob Goffner, left, Ajax Pipe Line Company, and W. G. (Bill) Hanrahan of the Oklahoma Contracting Company.

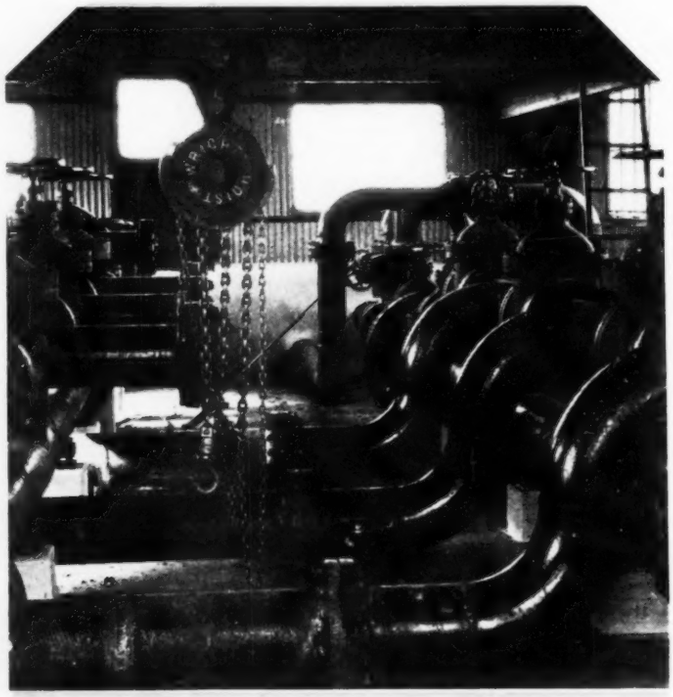
At the same time the construction company was showing its sustained speed, the Ajax engineers were making an equally impressive record in station construction.

Stations were ready about the same time the last section of line was tied in for its test, and long before December first, oil was in storage at Springfield station, the central point on the system.

This record was made without sacrificing good workmanship as is shown by the water tests made on completed sections of the line. Welding failures were few and far between with one 360-mile section showing only one failure in the welds.

Briefly, the specifications for the line required 40.483-pound pipe, acetylene welded joints with welds from one to 1⅛-inch wide, and 3/16-inch high. Pipe was to be lowered in a ditch 30 inches deep and 22 inches wide and tested with water at 750 to 800 pounds pressure.

When construction work was moving along at its top speed the 10 gangs combined were turning in daily progress reports that read something like the following: Ditch, 49,756 feet; coating, 47,009 feet; lowering, 33,400 feet; backfill, 44,000 feet; welding, 45,100 feet; tie-in, 51,601 feet. Over a 15-day period the same gangs were reporting progress as follows: Grade, 115,732 feet; ditch, 634,863 feet; welding, 292,153 feet; cleaning, 653,306 feet; paint, 653,506 feet; dope, 652,816 feet; lowering, 651,341 feet; backfill, 632,600 feet; tie-in, 648,761 feet.



Section of manifold featured by radius bends.

Such progress, of course, required a heavy investment of machinery and equipment, a great deal of which was purchased new when the job was started. In all, listed among the heavy equipment and machinery, were 70 trucks, 44 cars, 73 tractors, four power shovels, eight other power machines, 16 ditching machines, 15 back-filling machines, 38 air compressors, 50 100-pound generators and 15 50-pound generators. Soon after the contractors started stringing on the west end near Jenks on June 26, approximately 4,000 men were on the pay rolls.

Because of the speed of construction and the extremely difficult working conditions the equipment would be subjected to, provisions were made at the start to care for expected trouble and reduce lost time and shut-downs to a minimum.

To accomplish this a system of central supply was inaugurated along with a maintenance program that dovetailed into it. The former is new to line construction, and while ideally adapted to this job it brought about a direct savings of several thousand dollars in purchases and was indirectly responsible for equipment being in service the maximum number of hours.

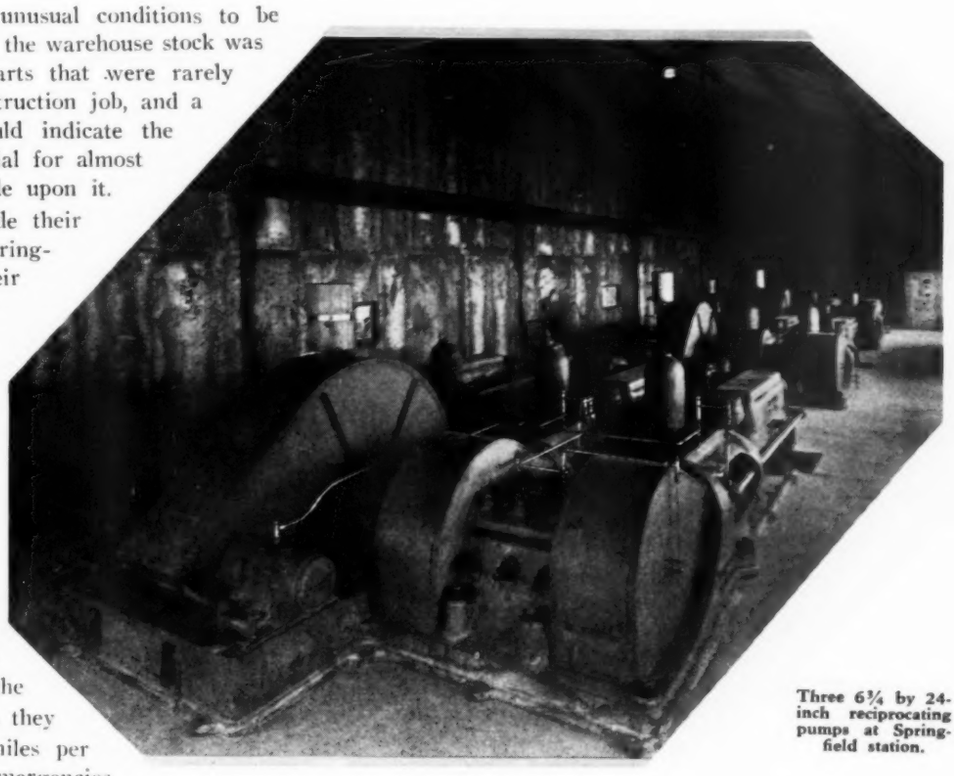
With the system of central supply all of the purchases were placed in the hands of a few experienced buyers, eliminating, to a large extent, inexperienced buyers in the gangs using any of the various methods of purchasing. A warehouse was leased in Springfield and two light delivery trucks used to distribute the material ordered from the warehouse. This permitted orders coming in one evening to be delivered the following morning. Purchases made by the gangs were made through the paymaster, but these were only made to prevent loss of time for lack of material.

When the warehouse was leased past experience was drawn upon by the buyers to purchase the stock of small supplies and spare parts. A more careful study was made to determine what parts of machinery would likely be

broken when subjected to the unusual conditions to be encountered. Consequently, when the warehouse stock was purchased it contained many parts that were rarely needed on the average line construction job, and a hasty check of the stock would indicate the warehouse had stock and material for almost any demand that would be made upon it.

When the gang foremen made their daily progress reports to the Springfield office they also made their requisition for materials and parts. Each morning the two light delivery trucks were loaded with the orders from the gang foremen, which ranged from machinery parts to nails, files, belting, wire rope and wire, bolts, axes, buckets and numerous other items.

With the warehouse located approximately 200 miles from either end of the line it was not difficult for the trucks to reach the gangs because on the highways they could travel from 30 to 40 miles per hour. A third truck was used for emergencies.



Three 6¼ by 24-inch reciprocating pumps at Springfield station.

Tying into this system was the plan to care for maintenance. Each gang carried a repair man to maintain the welding equipment and the work he was unable to care for was sent to the Springfield warehouse where an expert mechanic was employed to handle all types of small repairs, for gasoline engines, compressors, gauges and welding equipment.

Another mechanic cared for the serious break-downs of machinery in the field and if he was so unfortunate as to have three or four machines down at one time, he made certain each machine was properly repaired before going to the next job. No machine was temporarily repaired by the field mechanic, consequently he was not continually harassed with the knowledge that several machines were down and some more likely to go out at any minute.

Despite the elaborate purchase of stock for the warehouse, there were many times when it seemed that the particular part ordered was "just out" or else it was a part that had never failed before. Those in charge of the system of central supply are of the opinion the plan is a successful one for a major job. While it was not expected to be a perfectly functioning one, it prevented the scattering of a large number of express orders of parts to different points on the line and prevented a great deal of delay due to machinery being down awaiting the arrival of parts.

Construction equipment assembled at shipping point ready to be reconditioned and moved.

Coupled with this plan two blacksmith shops were operated at points on the line and they also played an important part in saving time.

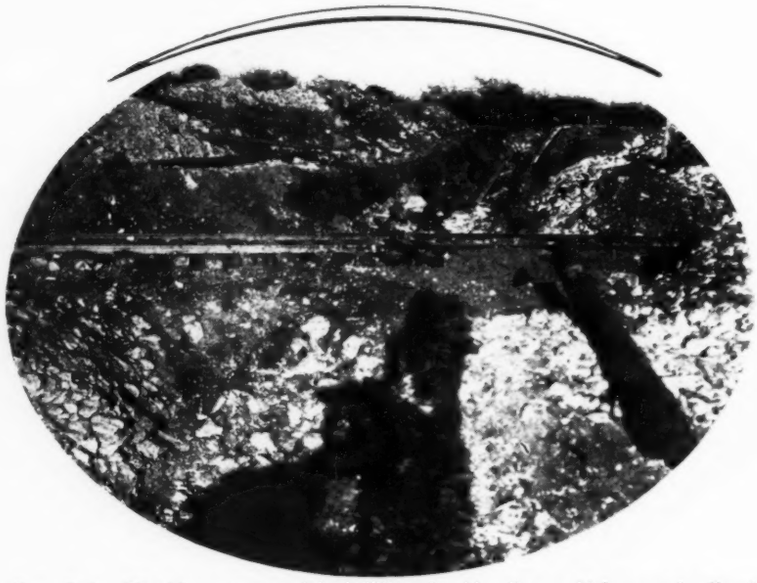
Later when it was practicable to centralize the shops at Springfield, this was done. The equipment for the blacksmiths included an air compressor to drive the air hammer, air drill and air-driven drill sharpener, electric drills, oil-burning forge, and tools.

Because of the large amount of rock along the line the shops were operated anywhere from 12 to 24 hours daily to keep the crews supplied with sharp drill steel and sharp picks, rooters, etc. By having the shops a more satisfactory service was afforded and the cost was considerably below what it would have cost to spread the work among blacksmith shops in the various towns along the line.

Crews in the field were supplied with sharp drill steel daily. When the delivery trucks left the warehouse each morning they carried a supply of sharp drill steel and as they made their deliveries to the gangs, sharp steel was exchanged for dull steel, which was taken to the blacksmith shops.

Welding supplies were handled by a fleet of trucks under the supervision of the welding superintendent. Carbide and rods were shipped to the nearest rail point and then distributed while the oxygen and acetylene drums were moved by truck from Tulsa, Okla., St. Louis and Kansas City, Mo.

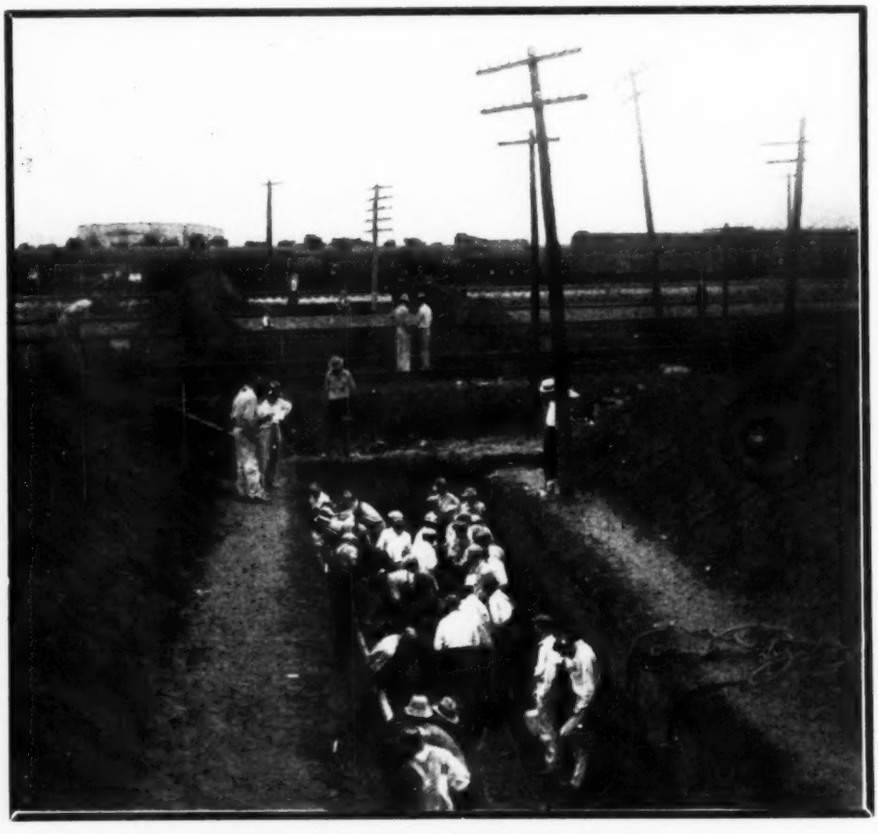
Another advantage of the central system of supply is the ability to mobilize machinery at the nearest shipping points when the job is completed and overhaul it for the next job in a speedier manner. The warehouse will have a great many of the replacement parts which will help to clean up the stock if desired. Those parts that are not available can be ordered and shipped to one point.



One of the difficulties encountered in building the Ajax line: a highway and railroad crossing which had to be blasted out.

In construction, the procedure in building the line was to string pipe on both sides of the right-of-way and have the firing line gang weld it in 200-foot sections for the tie-in gangs. The ditch was cut for No. 1 line, which was tied in, painted and wrapped and then back-filled. The same crew doubled back, or another crew moved behind, cutting the trench for No. 2 line, and the back-fill crew dressed the covering over both ditches after covering No. 2 line.

It required approximately 30 minutes to make a roll weld. Approximately 200 miles of the pipe was made in 40-foot joints, but the remainder was composed of random length joints ranging anywhere from 9.6 to 20 feet in length. Approximately 187,000 welds were made to build the line, which required approximately 420,000 pounds of welding rod. Around 1,340,000 pounds of carbide was used, along with 38,000 cylinders of oxygen and 31,000 cylinders of acetylene.



Tunnelling under roadbed for multiple rail crossing.

Blasting the right-of-way offered more to retard construction probably than any other single phase. The machines were used to clean the trenches as much as possible but a considerable amount had to be done by laborers. Digging a little further into statistics, it is found that more than 443,000 pounds of dynamite were used, along with 427,000 caps and 1,150,000 feet of medium-burning fuse, which would require around two years to burn if in a single spool and burned at the rate of 45 seconds per foot.

One of the most interesting as well as spectacular features of the construction work was in building the river crossings. All of the crossings except the Missouri and Mississippi were made by welding the crossings on shore and pulling them across with tractors.

On the Missouri, the crossing was made when the river was extremely low and great difficulty was experienced in getting the barges and tug boat off sand bars. On both rivers a derrick boat, tug and barges were used to make the crossings. Most of the crossings were welded in sections on shore, shoved out, one section at a time, and tied in. When the pipe reached the channel another barge was loaded with pipe, a tractor and welding equipment. The remaining part of the crossing was made up on the barge and lowered into the channel and to the shore.

The spectacular part of this work was that the crews worked under the protection of machine guns and rifles, the menacing presence of which prevented raids by Illinois laborers. The latter had attempted to tie up construction work after being refused demands considered unreasonable. After making a raid on one crew, inflicting injuries to some of its members, and threatening further trouble, the armed protection for the crew was decided upon.

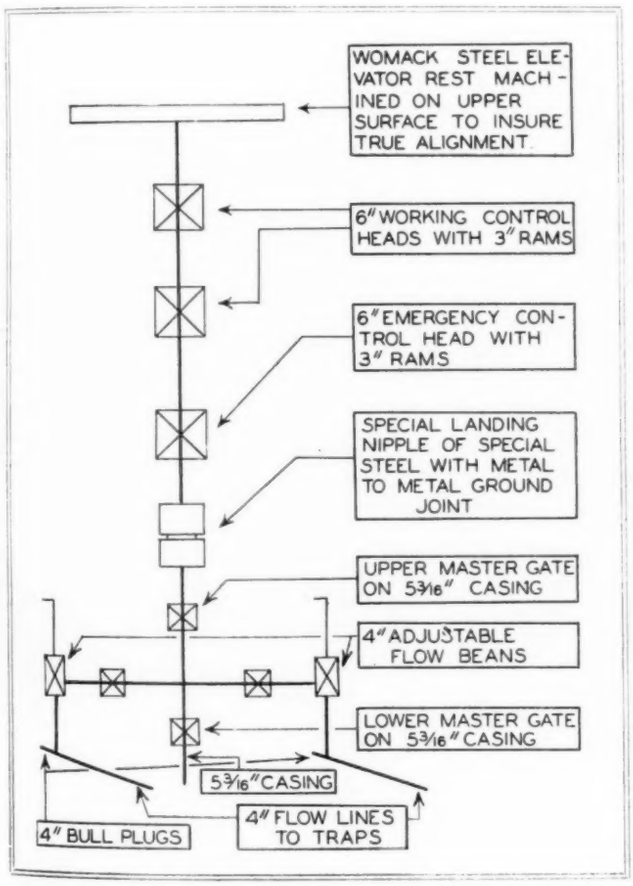
Long Strings of Tubing Run Under Pressure in Flowing Wells

By K. C. SCLATER

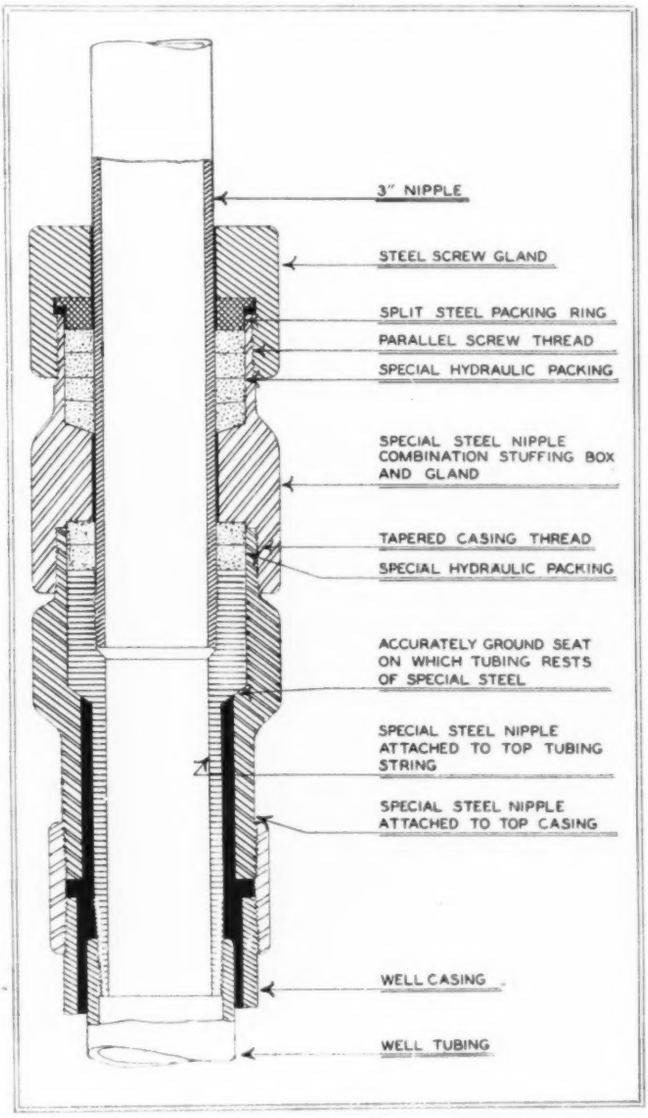
TWO of the seven deepest oil wells in the world today, flowing naturally and located in the famous Big Lake field, Texas, have recently been tubed to a depth of 8485 feet and 8617 feet, respectively. These are the Big Lake Oil Company's Santa Rita 2-C and the Group No. 1 Oil Corporation's University 3-B. In Santa Rita 2-C was installed a string of 3-inch, 10.2-pound, 11½-thread, high tensile strength alloy steel tubing, 8485 feet or one and five-eighths mile long, representing a total weight of more than 43¼ tons; and in University 3-B a tapered string of tubing consisting of 2690 feet of 3-inch, 9.3-pound, 10-thread, external upset, high tensile strength alloy steel tubing and 5927 feet of 4-inch, 12.75-pound, high tensile strength alloy steel tubing, 8617 feet in all, representing a total weight of more than 50¼ tons. The joints of tubing used in both wells were in 30-foot lengths.

Prior to the installation of tubing the wells had been producing by natural flow through the casing with a casinghead pressure of from 650 to 950 pounds per square inch. Average gas-oil ratios on both wells ranged from 11,000 to 12,000 cubic feet per barrel. It was in an effort to reduce the volume of gas produced with the oil that tubing of these deep wells was undertaken.

The job of tubing the Big Lake wells was carried out by the Southern States Company of Shreveport, La. This company in recent months has successfully tubed a number of flowing wells under pressure, notably wells in the Yates field, Pecos County, Texas, and in the deep Oklahoma City field.


WOMACK STEEL ELEVATOR REST MACHINED ON UPPER SURFACE TO INSURE TRUE ALIGNMENT
6" WORKING CONTROL HEADS WITH 3" RAMS
6" EMERGENCY CONTROL HEAD WITH 3" RAMS
SPECIAL LANDING NIPPLE OF SPECIAL STEEL WITH METAL TO METAL GROUND JOINT
UPPER MASTER GATE ON 5 3/16" CASING
4" ADJUSTABLE FLOW BEANS
LOWER MASTER GATE ON 5 3/16" CASING
5 3/16" CASING
4" BULL PLUGS
4" FLOW LINES TO TRAPS

Diagrammatic sketch showing arrangement of casinghead connections used in running 8,485 feet of 3-inch tubing under pressure in Big Lake Oil Company's well, Santa Rita 2-C, Big Lake field, Texas.


3" NIPPLE
STEEL SCREW GLAND
SPLIT STEEL PACKING RING
PARALLEL SCREW THREAD
SPECIAL HYDRAULIC PACKING
SPECIAL STEEL NIPPLE COMBINATION STUFFING BOX AND GLAND
TAPERED CASING THREAD
SPECIAL HYDRAULIC PACKING
ACCURATELY GROUND SEAT ON WHICH TUBING RESTS OF SPECIAL STEEL
SPECIAL STEEL NIPPLE ATTACHED TO TOP TUBING STRING
SPECIAL STEEL NIPPLE ATTACHED TO TOP CASING
WELL CASING
WELL TUBING

Sketch showing details of special landing nipple and method of packing off tubing above ground seat on Big Lake Oil Company's well, Santa Rita 2-C.

In the tubing of the two Big Lake wells described here, a crew of nine men on each well carried out the job to completion.

Careful consideration was given to the question of tubing sizes in these wells, and decisions as to sizes were made on the basis of a series of field tests and the known flow characteristics of the wells.

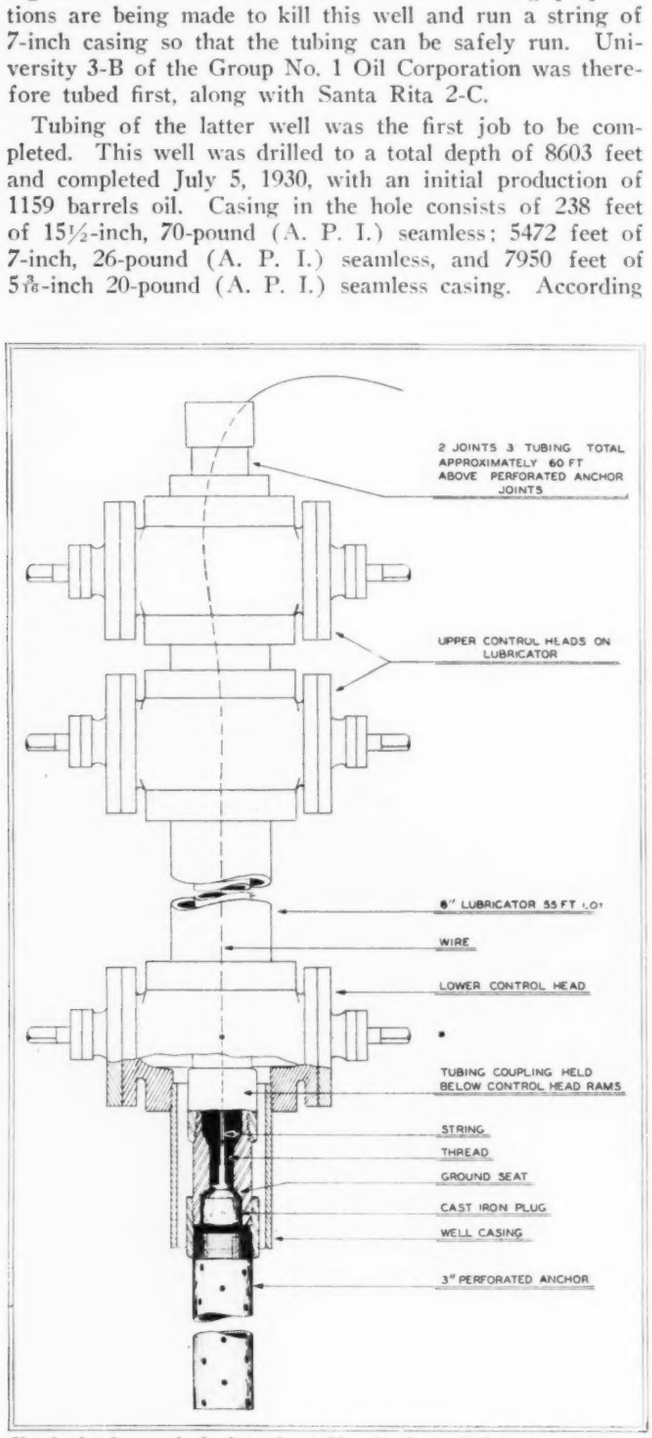
It is planned to tube all the deep wells in this field and Group No. 1 Oil Corporation's University 2-B and Big Lake Oil Company's 2-C were first on the schedule. Tubing of the former well, University 2-B, has been delayed on account of trouble encountered in the sanding up of casinghead connections, which rendered the immediate tubing of the well too hazardous. At this writing preparations are being made to kill this well and run a string of 7-inch casing so that the tubing can be safely run. University 3-B of the Group No. 1 Oil Corporation was therefore tubed first, along with Santa Rita 2-C.

Tubing of the latter well was the first job to be completed. This well was drilled to a total depth of 8603 feet and completed July 5, 1930, with an initial production of 1159 barrels oil. Casing in the hole consists of 238 feet of 15½-inch, 70-pound (A. P. I.) seamless; 5472 feet of 7-inch, 26-pound (A. P. I.) seamless, and 7950 feet of 5⅜-inch 20-pound (A. P. I.) seamless casing. According to these measurements, there is 653 feet of open hole below the 5⅜-inch casing.

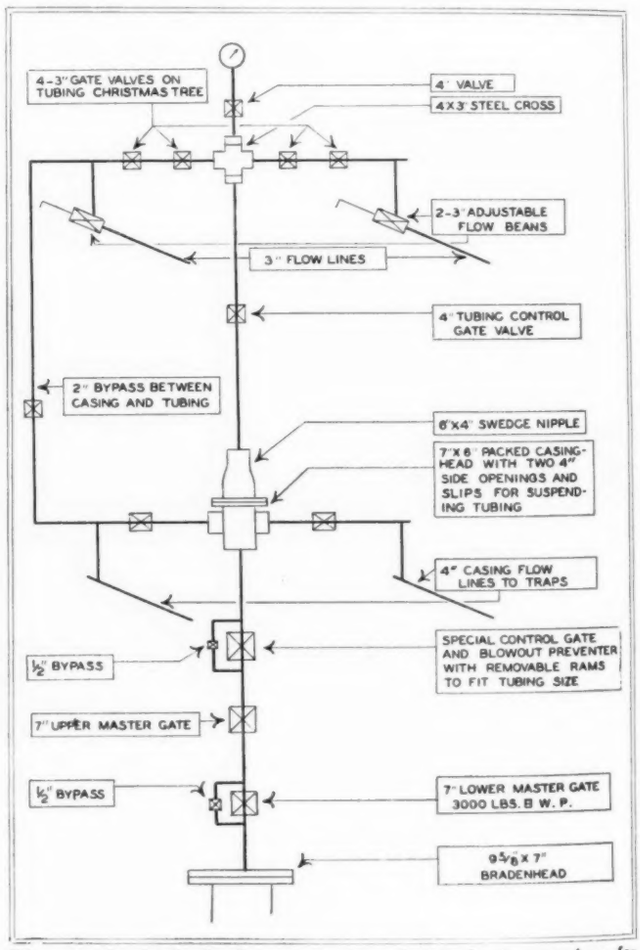
About three days before the tubing was started into well 2-C the casinghead pressure was reduced gradually from 950 pounds — the then operating pressure — to about 400 pounds, in order to facilitate the running of the tubing and eliminate as much as possible the hazard of high casinghead pressure. Arrangements at the casinghead are shown in an accompanying sketch. The well was produced through the lower—that is, the casing—Christmas tree while the tubing was being run, and the pressure on the upstream side of the flow bean was from 300 to 475 pounds per square inch. Above the upper master gate on 2-C (see sketch) it will be observed that a special steel nipple was installed, with an accurately ground seat for suspension of the tubing. Details of this nipple are shown in another sketch, and the method of packing off the tubing above the ground seat will be described later. This nipple has been designed and developed by the Southern States Company for use with the Otis tubing method.

Two perforated 30-foot joints of 3-inch tubing, each with seventy ⅜-inch perforations, were run on the bottom of the tubing. This necessitated the use of a lubricator 55 feet long, equipped with two control heads at the upper end in addition to a lower control head on the casinghead, into which the lubricator was screwed. To prevent flow through the tubing while it was being run in the hole, a cast iron plug—an exclusive feature of the Otis tubing method—which seats on a ground joint in a special steel nipple, was inserted in the tubing on the bottom of the first joint above the perforations.

In starting the tubing into the well, two joints were made

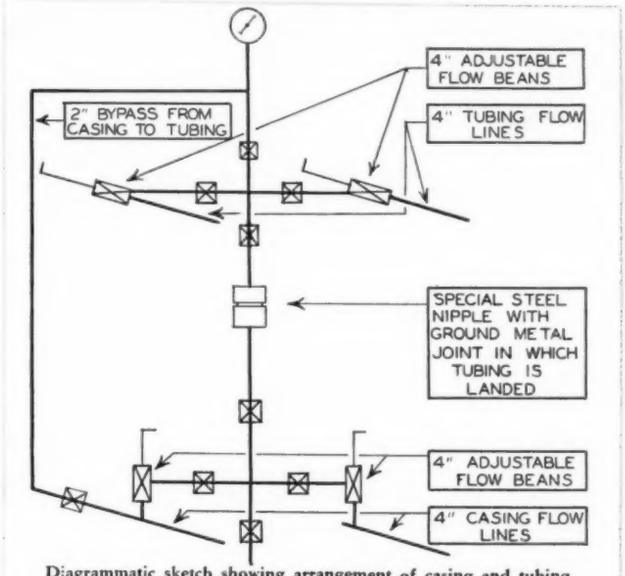


Sketch showing method of starting tubing in the well through a lubricator and the use and construction of the plug in the tubing in Big Lake Oil Company's well, Santa Rita 2-C.


4-3" GATE VALVES ON TUBING CHRISTMAS TREE
4" VALVE
4X3" STEEL CROSS
2-3" ADJUSTABLE FLOW BEANS
3" FLOW LINES
4" TUBING CONTROL GATE VALVE
2" BYPASS BETWEEN CASING AND TUBING
6"X4" SWEDGE NIPPLE
7"X6" PACKED CASING-HEAD WITH TWO 4" SIDE OPENINGS AND SLIPS FOR SUSPENDING TUBING
4" CASING FLOW LINES TO TRAPS
½" BYPASS
SPECIAL CONTROL GATE AND BLOWOUT PREVENTER WITH REMOVABLE RAMS TO FIT TUBING SIZE
7" UPPER MASTER GATE
½" BYPASS
7" LOWER MASTER GATE 3000 LBS. B. W. P.
9⅝"X7" BRADENHEAD

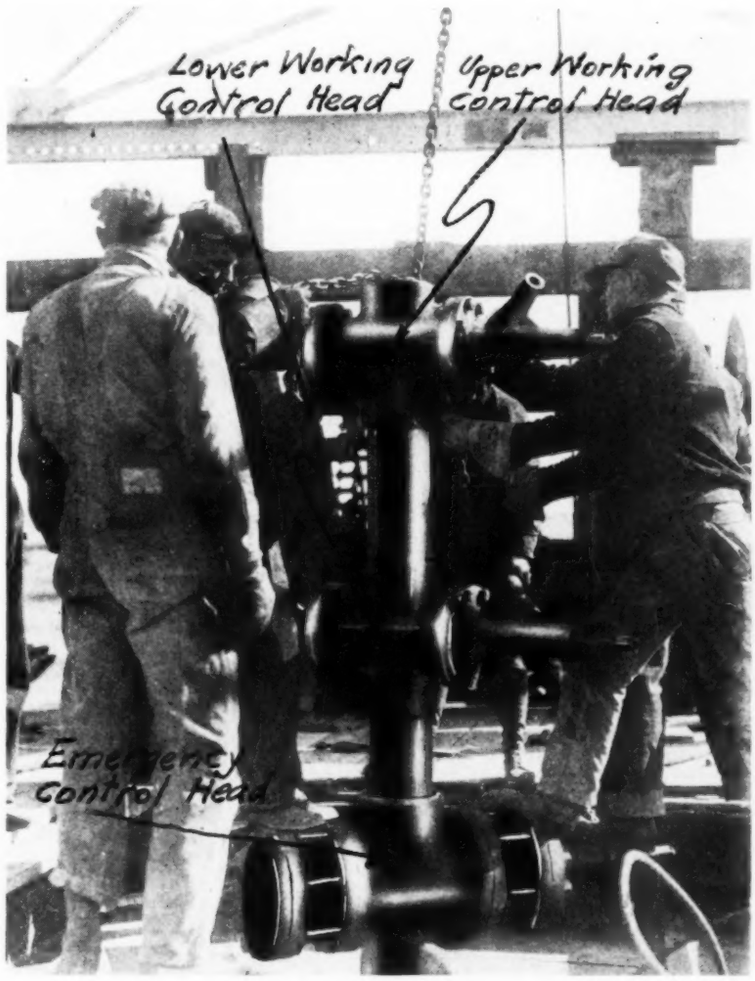
Diagrammatic sketch showing arrangement of casinghead connections for tubing flow on Group No. 1 Oil Corporation's University 3-B.

up and the cast iron plug inserted. These were then screwed into the perforated joints hanging inside the lubricator. The plug was held against the seat while snubbing in by means of a string and wire until it was below the lower control. As will be seen from the sketch, the string and wire attached to the stem of the plug was strung through the tubing. By holding the wire taut while snubbing the first blank joint of tubing the plug was held firmly on its seat. When the tubing reached the point where the lower coupling on the first blank joint above the perforations was just below the lower control head, the rams on the control head were closed on the pipe. The well pressure was then sufficient to hold the plug on its seat. To remove the wire, a quick jerk on the wire sufficient to break the string was all that was necessary. The coupling on the joint above the perforations, which was on the lower side of the control head rams, prevented the tubing from being blown from the hole.


4" ADJUSTABLE FLOW BEANS
2" BYPASS FROM CASING TO TUBING
4" TUBING FLOW LINES
SPECIAL STEEL NIPPLE WITH GROUND METAL JOINT IN WHICH TUBING IS LANDED
4" ADJUSTABLE FLOW BEANS
4" CASING FLOW LINES

Diagrammatic sketch showing arrangement of casing and tubing christmas trees on Big Lake Oil Company's deep well, Santa Rita 2-C.

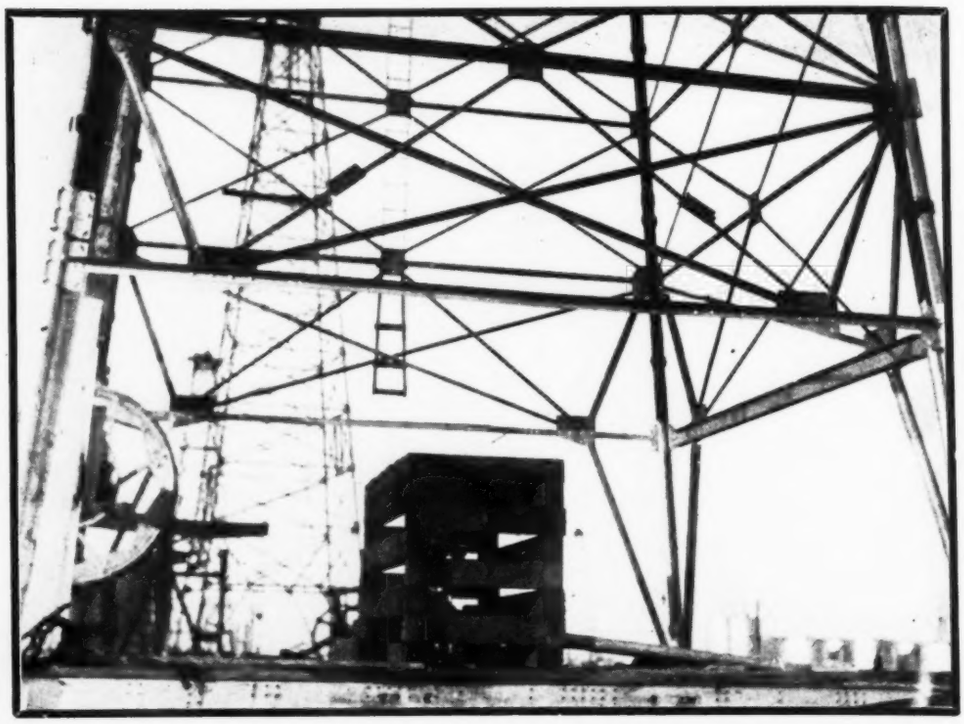
After the plug was set the lubricator was taken down in one piece by breaking the joint on the lower control head and lifting it over the two joints of tubing. As the length of the lubricator was 55 feet and the two joints of tubing about 60 feet, there was just sufficient head room to remove the lubricator without taking it apart. When this was done, the remainder of the control equipment was placed on the well. This consisted of two control heads surmounted by a steel elevator rest for insuring proper alignment of the tubing as it hung from the elevator slips. The two upper control heads were used as working heads and the lower one as an emergency. All control equipment used was designed for 3000-pound working pressure. The first 55 joints had to be snubbed in on well 2-C, after which the weight of the tubing was more than sufficient to overcome the upward pressure exerted by the well pressure on the bottom of the tubing. No great difficulty was met in running the tubing inside the 5⅞-inch casing, but in the open hole below, tight places in the hole were encountered, making it necessary to exercise the utmost vigilance while the tubing was being lowered. It was at this point that sedulous use of the weight indicator was brought into play to obviate any possible trouble by hanging up of the tubing. How delicate an operation the lowering of 8,000 feet of tubing in 600 feet or more of open hole will be appreciated when it is realized the minimum clearances under which the work was performed. It was estimated that the diameter of the open hole was about 4¾ inches, while the outside diameter of the 3-inch couplings used was about 4⅞ inches.



Here the two working control heads and the emergency control head are about to be taken off the Santa Rita 2-C well.

On Friday morning, November 21, 1930, at 11 o'clock, the 8,485 feet string of tubing was safely landed in the casinghead of Santa Rita 2-C. Just as soon as the steel nipple on top of the tubing was resting securely in the ground joint in the steel landing nipple in the casinghead the control heads were opened up to test the joint. Not a sign of leakage could be observed. When it was found that an effective shut-off had been obtained between the casing and tubing, the work of dismantling the control equipment was begun. Within ten minutes all connections down to the steel landing nipple were removed.

As an extra precaution, in case of the ground joint being disturbed, the nipple carrying the tubing Christmas tree was securely packed. Details showing the method of packing the landing nipple above the ground joint are given on an accompanying sketch. The



Structure of 10 x 10 timbers protecting the christmas tree on University 2-B well.

real purpose of the lower end of the combination stuffing box and gland is to insure that the tubing is held firmly on its seat. The lower packing is more in the nature of an effective filler ring that is flexible enough to yield sufficiently to permit the lower tapered screw joint of the stuffing box to be made up tightly, thus forming a gas-tight joint in case of leakage around the ground seat on which the tubing is landed. The steel screw gland or cap for the upper stuffing box has a parallel thread and two split metal rings or followers, so that it can be tightened or repacked if necessary. The steel landing nipple and method of packing is a development of the Southern States Company and has proven a safe, simple and reliable means of landing and packing off tubing in high-pressure wells.

After the tubing Christmas tree and bypass between the casing and tubing were connected up the inside of the tubing was loaded with water to about 5,000 feet from bottom. All this time, during the running of the tubing and the making up of casinghead connections, the well was producing through the casing flow line at a pressure of 300 to 475 pounds at the casinghead and 300 pounds at the trap.

After loading the tubing with water to 5,000 feet from bottom, the pressure was gradually built up on the casinghead to 1,650 pounds by flow bean adjustment. At this pressure the bypass was opened and the pressure allowed to equalize in the casing and tubing. The bypass was then closed and the pressure on the casing reduced by opening up the flow bean. The flow from casing was very vigorous and the pressure dropped to the trap pressure. Just as soon as a slight differential of pressure was created at the bottom of the well and the pressure inside exceeded that outside the tubing, the cast iron plug at the bottom of the tubing dropped out. This was indicated by a sudden drop in the tubing pressure. The tubing was then opened up gradually to the tubing flow line and the casing flow gradually shut off. After about 45 minutes the casing pressure reached 1,500 pounds and the pressure in the tubing was gradually reduced to about 600 pounds. Some trouble was encountered in keeping the well flowing at these pressures. However, after a few trials it was decided to carry about 1,650 pounds on the casing and 1,000 pounds on the tubing and flow at these pressures to permit a gradual readjustment of conditions at the bottom of the well.

Tests are now under way to determine the pressures and flowing conditions that will give the most economical gas-oil ratio. Thus far, pressures of from 1,500 to 1,600 pounds on the casing and 800 to 1,000 pounds on the tubing have been used.

For November 26, 27 and 28, the first three days of stabilized flow since tubing was placed in 2-C, the average daily oil production, according to available figures, was about 1,956 barrels with a gas-oil ratio of 9,200 cubic feet gas, as compared with a daily average of 2,387 barrels oil and gas-oil ratio of about 10,800 cubic feet gas for three days (November 10, 11 and 12) before the well was tubed.

Tubing was started into well 2-C Saturday, November 15, and completed Friday, November 21, 1930. The actual time it took to run the 8,485 feet of tubing was about 54 hours. This does not include the time of moving in equipment and rigging up. All work was done during daylight. Running tubing to such depth under pressure is yet considered too hazardous to be done at night.

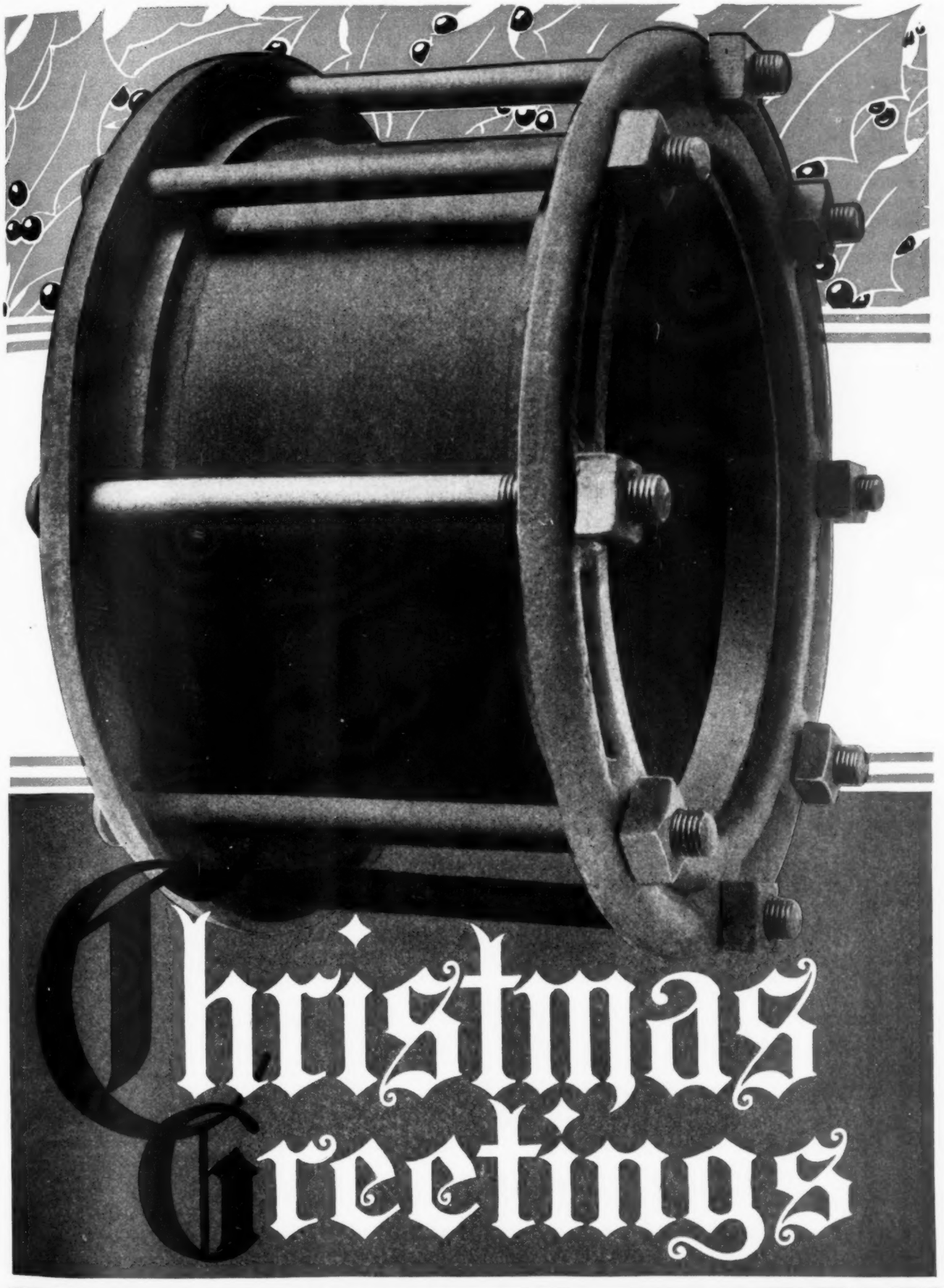
On Group No. 1, Oil Corporation's well 3-B, one perforated joint of 3-inch tubing with two hundred ⅜-inch holes was run on the bottom of the tubing string, thus making it necessary to use a lubricator only one joint long of 7-inch O. D. casing. Except for this fact the procedure followed in starting the tubing in the hole was similar to that adopted at 2-C. As the derrick had been removed from this well it was necessary to erect a steel derrick to run the tubing.

This well was drilled to a total depth of 8,633 feet and completed June 24, 1930, with an initial production of 270 barrels. The casing in the well consists of:

104 feet of 20 -inch, 90-pound Casing
3,037 feet of 13⅜-inch, 61-pound (A. P. I.) Casing
5,812 feet of 9⅝-inch, 40-pound (A. P. I.) Casing
7,995 feet of 7 -inch, 30-pound (A. P. I.) Casing

This leaves 638 feet of open hole below the 7-inch casing. However, on account of the larger hole, there was more clearance in the open hole even with the 3-inch upset tubing than was the case in 2-C.

The arrangement of casinghead connections while running the tubing was similar to that on 2-C, except for the addi-



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tion of a special control gate and blowout preventer with rams for 4-inch tubing, and the use of a 7-inch by 6-inch packed casinghead with two 4-inch side openings and provision for landing the tubing on slips. A diagrammatic sketch shows the final casinghead hook-up after the well was put on tubing flow. Referring to this sketch, the well produced through the lower Christmas tree while tubing was being run. It was necessary in preparing 3-B for tubing to shut the well in for about one and one-half hours. During this time the casinghead pressure rose rapidly to a dangerous figure.

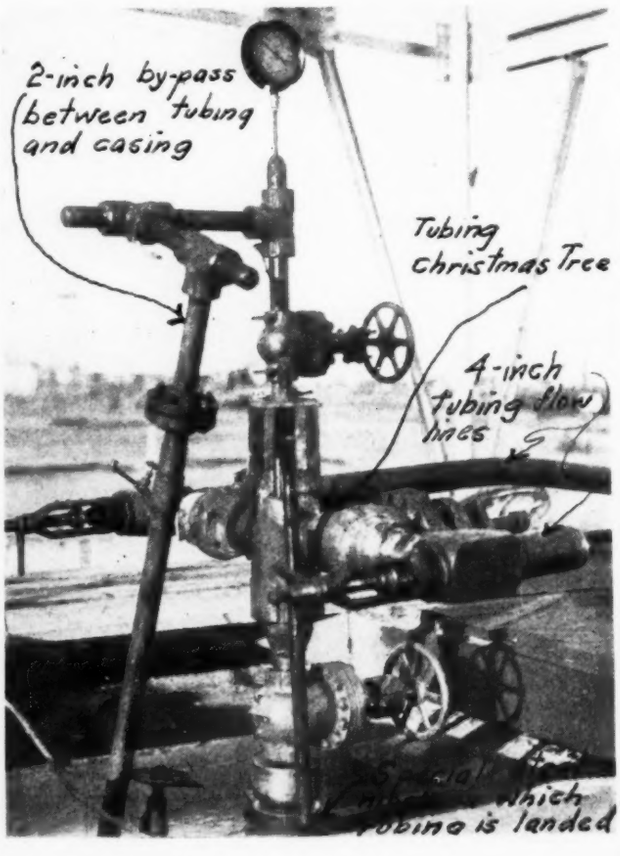
Before tubing was run this well had been producing under a casinghead pressure of 600-650 pounds per square inch. While being tubed the average casinghead pressure was 275-300 pounds per square inch. After the first blank joint was snubbed in through the lubricator and the plug securely placed, the lubricator was removed and the two tubing control heads, previously on top of the lubricator, connected to the well. As on 2-C, three control heads were used, the two upper as working heads and the lower as an emergency head.

Only 17 joints were required to be snubbed in this well. A special steel nipple 20 inches long, with female threads, was used as a swage between the 3-inch and 4-inch tubing.

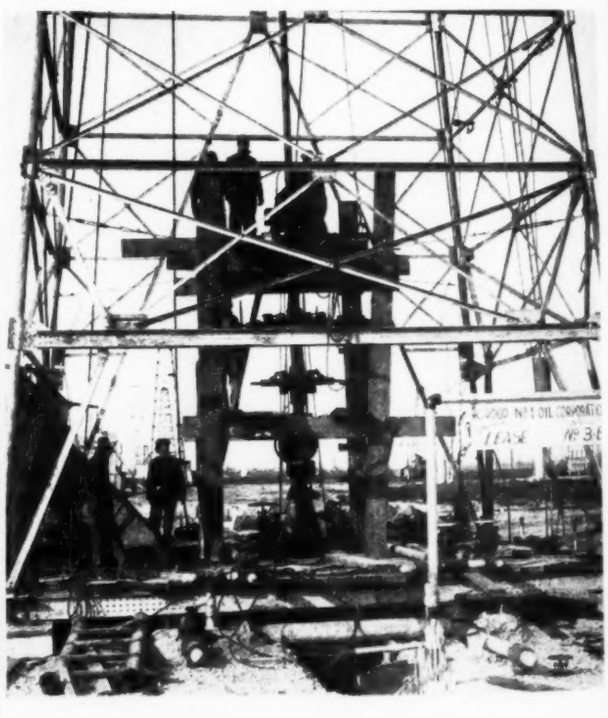
There were no serious difficulties in running the tapered string of tubing. It was quite free to 8,617 feet or about 18 feet off bottom. The weight indicator was sedulously observed until the tubing was landed in the casinghead. The operation of setting the tubing in this well was slightly different from that of 2-C. After closing the rams on the blowout preventer (see sketch) and disconnecting the flange on the bell of 7-inch by 6-inch head, all the fittings above and including the bell on the casinghead were lifted by auxiliary hoisting equipment in order to set the tubing slips and pack off the tubing. The landing joint had also to be unscrewed after the tubing was set in slips. In setting the slips the tubing was moved slowly up and down a few times. This whole operation, which took only 19 minutes, necessitated shutting in the well. During this time the casinghead pressure built up to 2,100 pounds.

At this writing the well flowing pressures are 650 pounds on the tubing and 1,125 pounds in the casing. These pressures will be maintained for a few days to give sufficient time for readjustment of pressures at the bottom of the hole. Tests will then be made to determine the proper flow rate for the most economical gas-oil ratio. It is reported that, so far, there has not been any appreciable change in the rate of production and in the gas-oil ratio of 3-B since it was tubed. It is expected, with the tapered tubing flow string in the well, that a wide range of efficient flow conditions will be obtained.

It is a notable fact that throughout the operation of tubing these two wells there was a complete absence of loss of oil or gas. Indeed, so thorough were the preparations made and adequate the equipment used, that the setting of the more than mile-and-half long strings of tubing into their resting place in the casinghead appeared a very commonplace operation. The skill and ease with which the job was handled was a revelation to those fully cognizant of the hazards involved.



At left—Christmas tree on well Santa Rita 2-C of Big Lake Oil Company, after well was tubed.
Below — Running tubing under pressure in Group No. 1 Oil Corporation University 3-B, Big Lake field, Texas.



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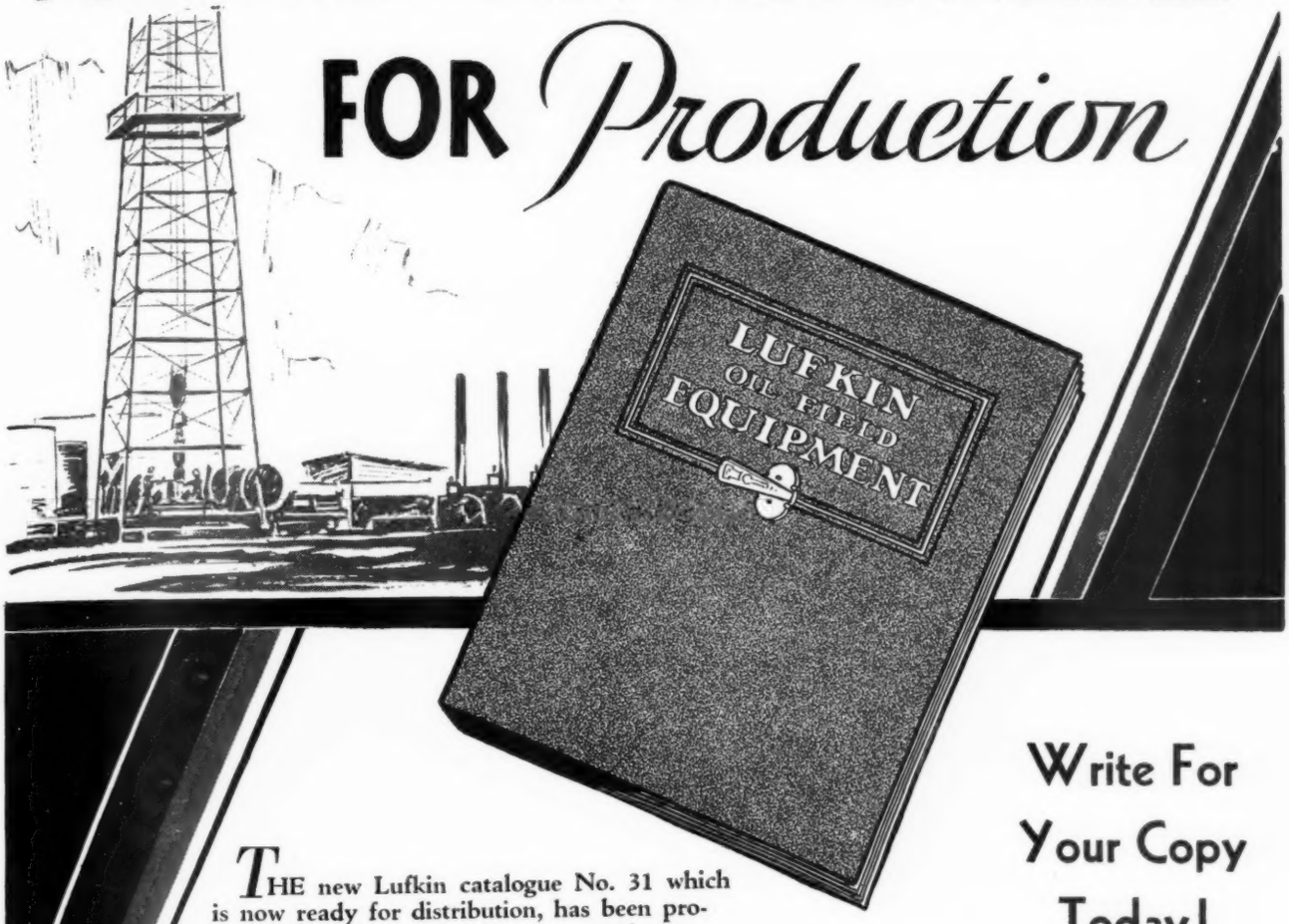

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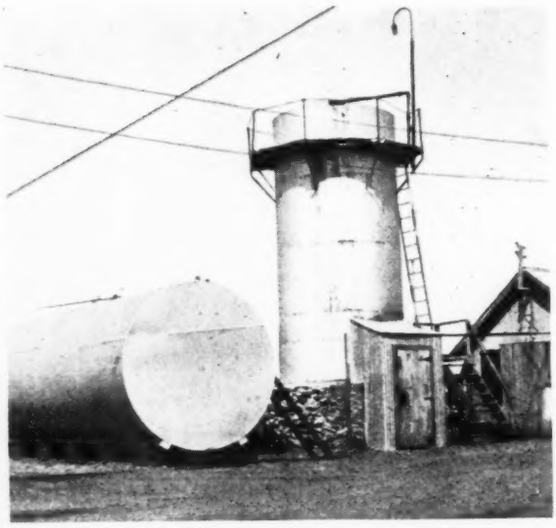
Methods *of* Refining Montana Crudes

By F. R. STALEY



Light Oil Agitator, Big West Oil Co., Kevin, Mont.

UNTIL recently most of the refineries in the State of Montana were topping plants of small capacity. The Arro refinery at Lewistown was one of the few operating a cracking unit. During the past year the International Refining Company completed a construction program which modernized its plant at Sunburst. The new equipment includes a DeFlorez cracking unit. This plant processes crude from the Kevin-Sunburst Field. The Laurel Oil and Refining Company built a modern refinery at Laurel to refine Basin crude from Wyoming. This is a combined topping and cracking plant. The Donnelly cracking process is installed. This plant has a capacity of 1,500 barrels per day.

Treating Problems

Since most of the crude oils refined in the state possess a high sulphur content, the treating problems involved in producing a stable gasoline that will pass specifications are usually very difficult to solve. The state inspection department checks the gasoline sold in the state very carefully, especially with respect to the sulphur content. Refinery chemists are constantly trying to work out an effective and economical method of treating light oils.

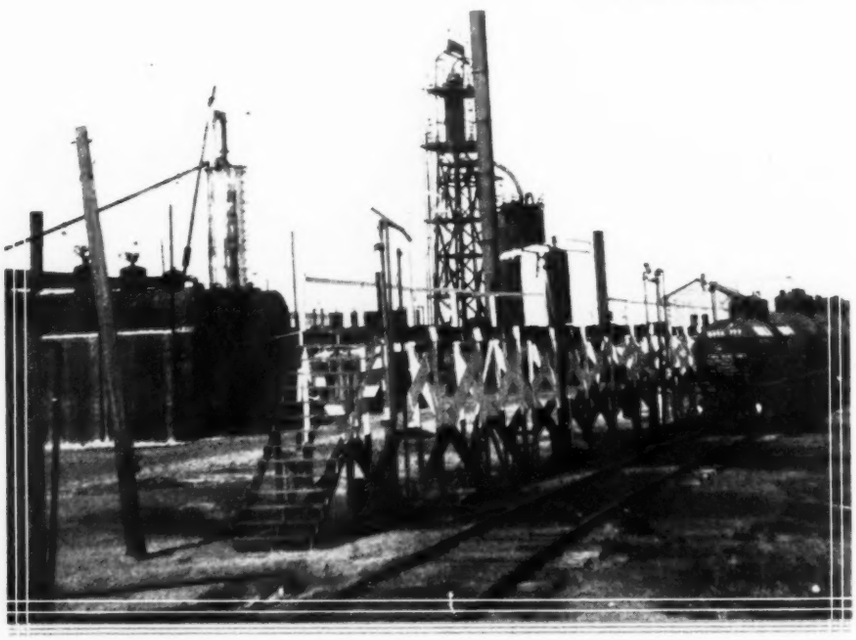
Arro Refinery

The refinery of the Arro Oil and Refining Company, located in the central part of the state of Montana, at Lewistown, runs a variety of crudes including Cat Creek, Pondera, Lake Basin and Osage. It has a capacity of 1,500 barrels per day, and the principal units consist of a battery of crude stills, a rerun unit and a cracking unit.

This refinery was built in 1921, and was one of the first in the state. E. L. Allen is general manager of the company, and Paul Jones is superintendent of the plant.

On account of the number of different crudes run and the high sulphur content of most of these, many treating problems had to be solved in order to manufacture a high quality

Cracking unit and loading rack, Arro Oil and Refining Co.



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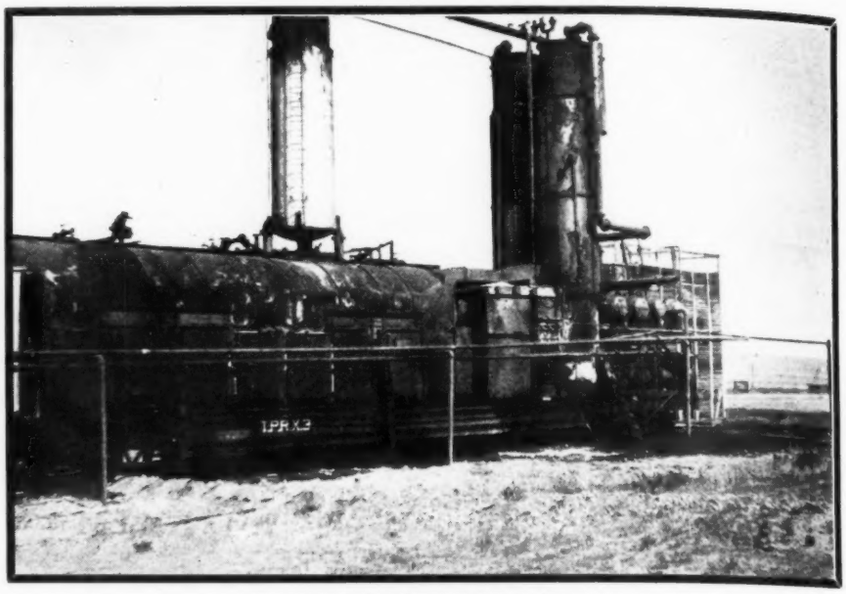
motor gasoline. Research chemists at the plant are working continually on these problems and have developed some very successful methods of treating both the straight run and cracked distillates.

Cat Creek Crude presents no refining difficulties, but it is available only in limited quantities. It is necessary only to distill and fractionate the overhead. The yields are about 70 per cent of straight run motor gasoline, and 12 per cent of 40-42 gravity A. P. I. kerosene. These fractions require no chemical treatment.

The black crudes run at the plant are topped, and the reduced crude is cracked in the unit to coke, for which there is a good local market. The crude battery consists of two shell stills 10 by 30 feet, each equipped with a bubble plate fractionating tower 5 by 26 feet high. The stills are fired with fuel oil or gas from the cracking unit. The vapors are fractionated into gasoline, kerosene, and tractor distillate. The bottoms, having an initial boiling point of about 572 degrees F. and approximately 23 A. P. I. gravity, are charged to the cracking unit.



Portable Refinery, Shelby, Mont.

About 600 barrels per day are charged to the units. The average yield is about 80-85 per cent of pressure distillate, which yields about 68 per cent of 410 degrees F. end point motor gasoline on rerunning. An 18 degree Be caustic soda solution is pumped into the vapor line to minimize corrosion of the equipment. A 940 degrees F. transfer temperature is used. The usual run to coke is about 144 hours. The reaction chamber on this unit is 10 by 30 feet.

The rerun unit consists of a shell still 10 by 30 feet, equipped with a bubble tower. The pressure distillate is charged through vapor heat exchangers to the still.

The gasoline is treated in a closed continuous system. Special procedures have been worked out for the various crude distillates. A modification of the split plumbite method is usually used. The procedure consists of first sweetening with sodium plumbite, washing, treating with 66 Be sulphuric acid in two successive contacts, the first being a so-called water acid to eliminate moisture. About 8 to 10 pounds of acid are used per barrel. The treated distillate is rerun with fire and steam and the overhead is given a caustic soda wash. By various modifications of the procedure it is possible to treat a sweet motor fuel containing under 0.1 per cent sulphur from the various crudes run at the plant.

Although a generous water supply is available from the river, the boiler feed water is obtained from several wells drilled to depths from 175 to 550 feet.

The Shelby Refining Company operates a unique refinery at Shelby. The plant consists of a distillation unit mounted on a flat car. It tops about 1,100 barrels per day of Kevin-Sunburst crude, delivered from the field by pipe line.

The cuts from the crude consist of gasoline, tractor distillate, gas oil, and a residuum of fuel oil or 20 A. P. I. gravity.

Cuts on Crude

Gasoline	60° A.P.I.
Gasoline	52° A.P.I.
Tractor Distillate	39° A.P.I.
Gas-Oil	32° A.P.I.

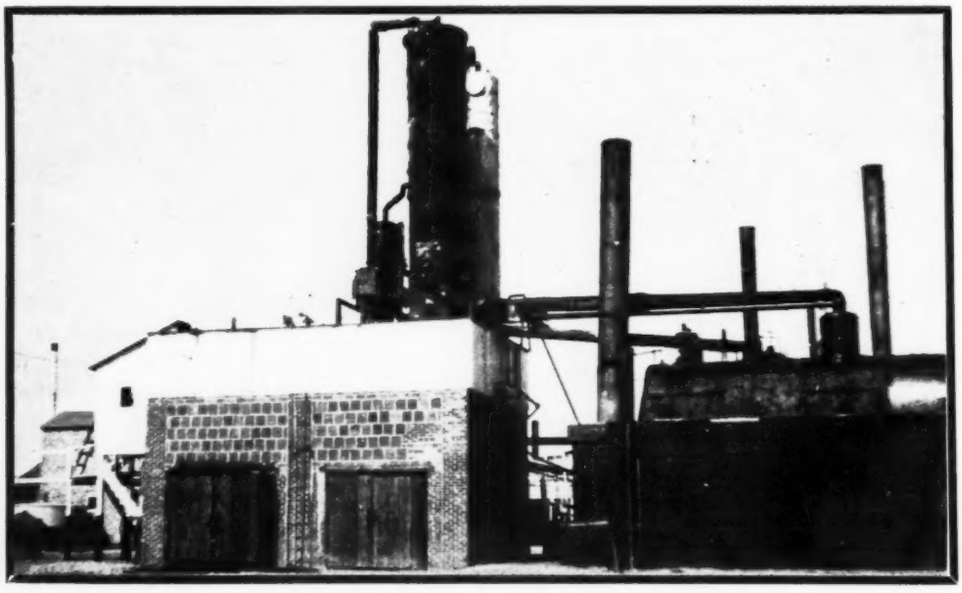
The Kevin-Sunburst crude is about 30 A. P. I. gravity, and contains about 1.5 per cent of sulphur. It yields about 17 per cent of straight run gasoline of 435 degrees F. end point.

Corrosion

This plant treats the straight run gasoline with sodium plumbite solution to make it sweet and non-corrosive. The sulphur content of the finished gasoline is under 0.1 per cent.

Due to the hydrogen sulphide content of the crude, the vapor and rundown lines must be replaced at regular intervals.

City water is used at the refinery. It is cooled by circulation over a cooling tower.



Rerun still, Arro Oil and Refining Co.

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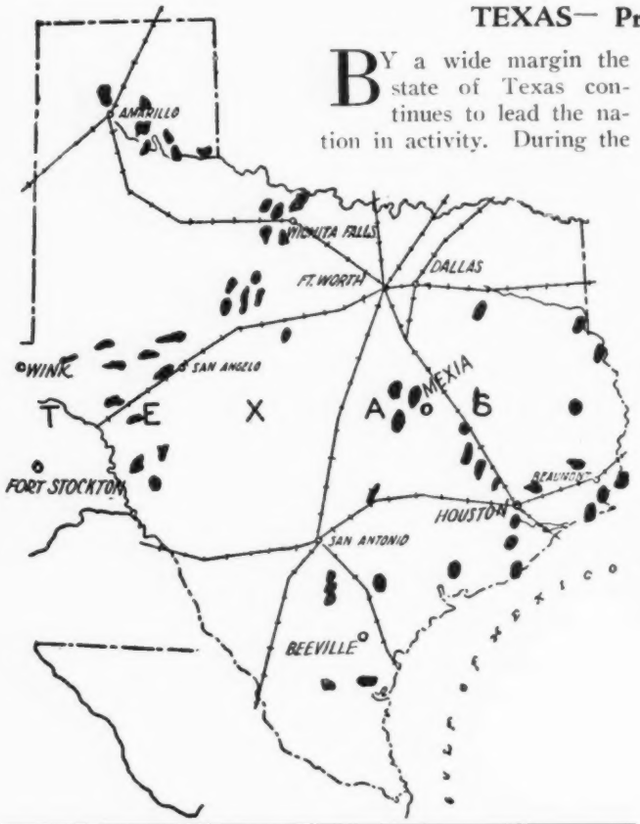
Latest Activities *in the* Oil Fields*

TEXAS— Production, 1929—299,054,250 Barrels



BY a wide margin the state of Texas continues to lead the nation in activity. During the past month this state had a total of 518 drilling permits issued, while there were 387 tests completed. The drilling reports carry 890 drilling wells and 256 rigs. It is interesting that this state has no one particular field that is outstanding in activity. The Gulf Coast area continues to boast of the most active fields.

A review of some of the active fields shows the following activity (monthly figures):

	POOLS			
	Van	Pettus	Refugio	Barber Hills
Number of Permits	23	7	3	7
November Completions	22	5	6	9
Number of Rigs	3	5	1	4
Number Drilling Wells	24	9	25	21
Gravity of Oil	35	35 to 48	26	35
Depth of Production	2600	4000	6500	6500
Type of Tool Used	Rotary	Rotary	Rotary	Rotary
Number Casing Strings	2	2	3	3

(Cable tools are also used in some of the fields in the state)

In the Van and Pettus fields it is a practice to tube all wells for production. Several wells in these pools are now being pumped.

CALIFORNIA
Production, 1929—292,321,700 Barrels

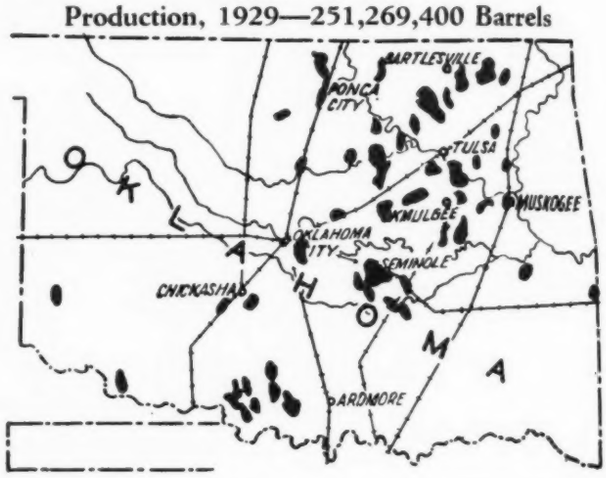
California now ranks third in activity. It has 437 drilling wells and 115 rigs. Last month the state showed 108 permits and 112 completions.

The general practice in the Kettleman Hills field is to set either three or four strings of casing.

A review of the active fields is as follows:

	Playa Del Rey	Long Beach	Kettleman Hills	Elwood
Number of Permits	57	13	5	4
Number Completions	42	31	0	10
Depth of Production	6000	7000	8300	3500
Number Drilling Wells	100	72	10	8
Gravity of Oil	23	36	60	37
Type of Tool Used	Rotary	Rotary	Rotary	Rotary

OKLAHOMA
Production, 1929—251,269,400 Barrels



Oklahoma ranks second in activity, although operations in the state continue to decline. Active fields in the state are showing a sharp drop in activity. Rotary drilling tools are the principal means of making hole in the Sooner State, with some cable tool operations in the shallower fields of the northeastern sector.

A summary of the state and its two most active fields is as follows:

	Entire State	Oklahoma City	West Asher
Number of Permits	228	28	7
November Completions	256	59	10
Number of Rigs	102	19	2
Number Drilling Wells	552	93	8
Gravity of Oil	36	39	37
Depth of Production	.....	6400	3500
Type of Tool Used	Cab.-Rot.	Rotary	Rotary
Number Casing Strings	.....	3	2

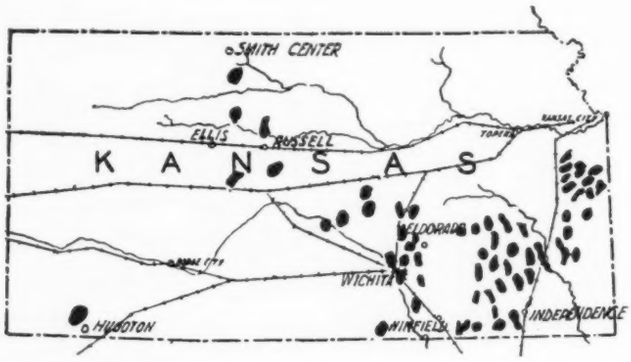
Depth of production in the state varies a great deal, and the number of casing strings depends largely upon the depth. The average gravity of oil in the state is probably 36 degrees Beaume.

* All statistics as of December 1st.

● **Denotes oil and gas fields.**

The Westcott Valve
Company wishes
you a very Merry
Christmas and a
most prosperous
and happy New Year
A. A. Wadsworth
VICE PRESIDENT

KANSAS—Production, 1929—40,991,450 Barrels



With approach of winter and due to general market conditions, Kansas is showing a marked slump in activity, but it still ranks at the foot of the leaders.

Following is a review of the activity in the state:

	Entire State	Eastborough	Hugoton
Number of Permits	73	4	8
November Completions	68	9	8
Number of Rigs	37	7	7
Number Drilling Wells	175	10	9
Gravity of Crude	.....	36	gas
Depth of Production	.....	3250	2750
Type of Tool Used	Cab.-Rot.	Cab.-Rot.	Cab.-Rot.
Number Casing Strings	.....	2	2

Eastborough field has two producing horizons, one being at 2950 feet in addition to the one at 3250 feet. Two strings of casings are set where rotary tools are used and four where standard tools are used for drilling.

ARKANSAS

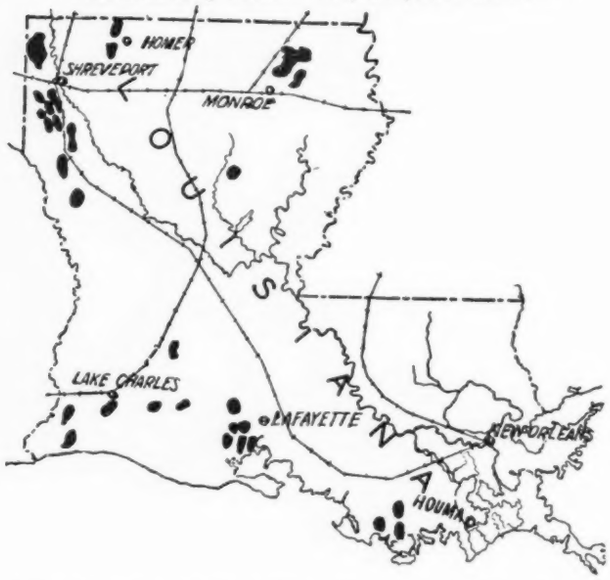
Production, 1929—25,372,700 Barrels

Only a few and scattered completions are being made in the oil fields of southwestern Arkansas. A tabulation of operations during the past month showed the following activity: Ten drilling permits, 15 completed tests, 10 rigs and 44 drilling wells.

Although the depth is not great, operators employ rotary equipment for doing the drilling. This is because of the soft formations encountered and frequent heavy gas pressures.

LOUISIANA

Production, 1929—21,172,000 Barrels



Louisiana showed 76 drilling permits and 82 completions, with 50 rigs and 140 drilling wells. The Gulf Coast area of the state is the most active with 33 completions, 7 rigs and 39 drilling wells. Most of the activity in the northern part of the state is operated out of Shreveport and is principally in the Zwolle district. Rotary tools are used.

Considerable attention of the operators here is being turned to the eastern neighbor state, Mississippi, which is a newcomer into the oil states. Most of the activity in Mississippi is around Jackson, where quite a gas play is being developed. The state had 6 completions last month and has 16 rigs and 29 drilling wells.

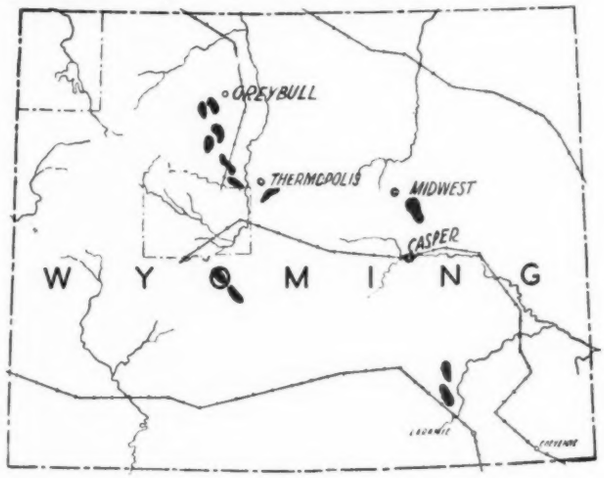
●Denotes oil and gas fields.

WYOMING

Production, 1929—19,388,000 Barrels

Wyoming, the most active state in the Rocky Mountain district, has 110 drilling wells and 23 rigs. The past month it had 19 completions. Both rotary and cable tools are used in this field, with the latter type predominating.

One of the best completions in months was that in the Osage pool of northeastern Wyoming. This well is flowing 800 barrels per day from 1730-34 feet.



NEW YORK

Production, 1929—3,345,000 Barrels

PENNSYLVANIA

Production, 1929—11,905,000 Barrels

The state of Pennsylvania had 76 completions and shows 12 rigs and 51 drilling wells. Bradford district continues to lead, having 37 completions, 5 rigs and 21 drilling wells. New York state, just north of Pennsylvania, and where a nice gas field is being developed in the southwest corner, had 8 completions. Cable tools are used in these two states.

ILLINOIS

Production, 1929—6,304,000 Barrels

The state of Illinois had 26 completions, 2 rigs and 30 drilling wells. The drilling is being accomplished by the cable tool method. St. Clair County is the most active in drilling, with 9 drilling wells.

● Denotes oil and gas fields.

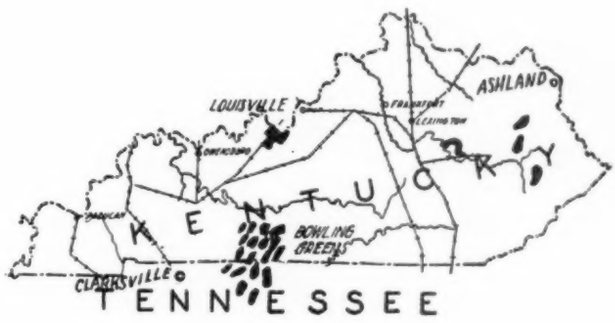
KENTUCKY

Production, 1929—7,776,000 Barrels

There were 83 completions, 10 rigs and 151 drilling wells shown on the drilling report of Kentucky during the past 30 days.

The state of Tennessee has but one rig and 15 drilling wells. There were no completions last month.

Cable tools do the drilling work in both Kentucky and Tennessee.



TENNESSEE

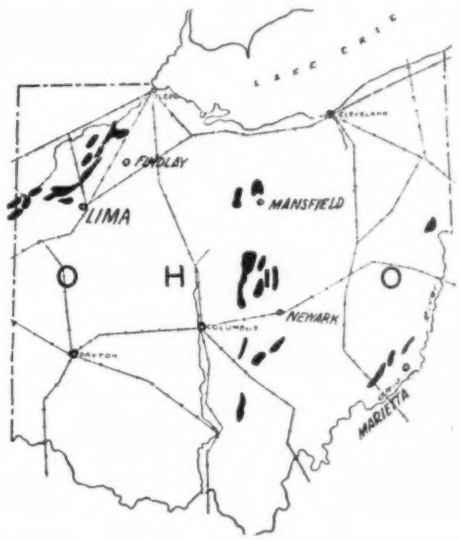
Production, 1929—19,000 Barrels

OHIO

Production, 1929—6,708,000 Barrels

Ohio had 161 completions, of which 123 were in the central area. The state has 50 rigs and 190 drilling wells. Central Ohio also leads in this work, having 160 drilling tests and 45 rigs. This division of the state is completing a number of fairly good oil producers, with numerous failures and a few gas wells.

Cable tools are used for the drilling of wells in Ohio.



WEST VIRGINIA

Production, 1929—5,587,000 Barrels

The state of West Virginia had 22 completions, 4 rigs and 42 drilling wells. The wells are drilled with cable tools. Completions in this state are practically all small producers, many of which are put right on the pump.

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You may enter one or more letters.

Write on one side of paper only.

All statements must be truthful.

Photograph may accompany letter if desired.

Anyone except our employees are eligible to enter.

Contestants must mail letters not later than December 31, 1930.

In event of a tie for any of the prizes, same award will be paid to each of the tied contestants.

Write about your experience or someone else's experience.

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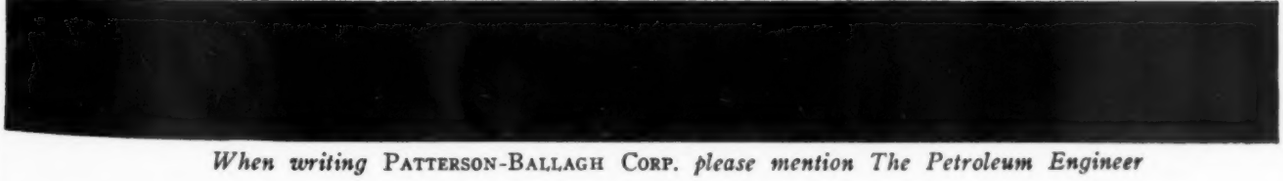

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NEW MEXICO

Production, 1929—1,395,600 Barrels

The Hobbs field of southeastern New Mexico dominates the activity of this state. At this time heavy restrictions on drilling and the coming of winter have put a "damper" on any increased drilling.

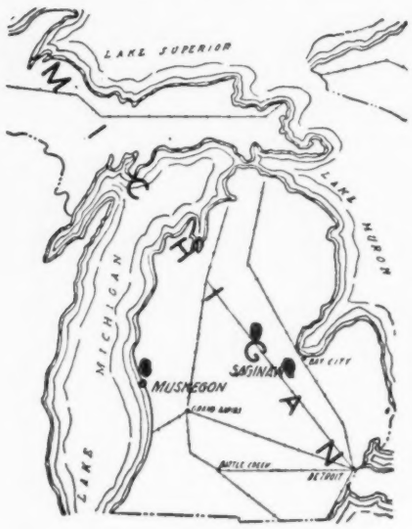
The entire state has 99 drilling wells and 14 rigs, with 31 completions reported last month. Of this number Hobbs had 28 of the completions, 2 of the rigs and 24 of the drilling tests.

The producing horizon at Hobbs is 4200 feet and is reached with rotary tools. It is a general practice to set three strings of casing. The gravity of the oil averages 35 degrees. The town of Hobbs is headquarters for the supply stores and oil men.

Because of the importance of the Hobbs field it is very likely that much additional exploration in undeveloped areas of the state will be conducted whenever the markets are of such condition as to permit extensive wildcatting.

MICHIGAN

Production, 1929—4,500,000 Barrels

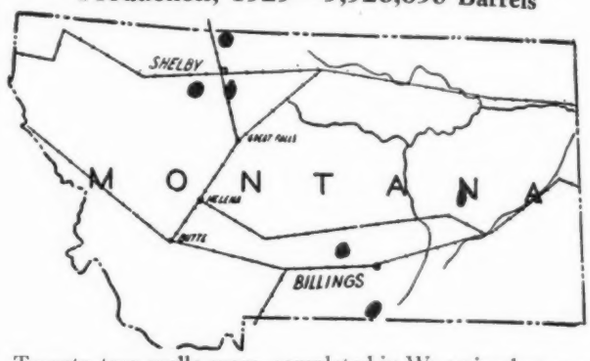


Michigan, with a decline in the number of completions, showed an enlargement in the number of rigs and drilling wells. The state had 22 completions against 35 the previous month and has 112 drilling wells and 61 rigs. Rotary tools are used for the development of Michigan oil fields.

● **Denotes oil and gas fields.**

MONTANA

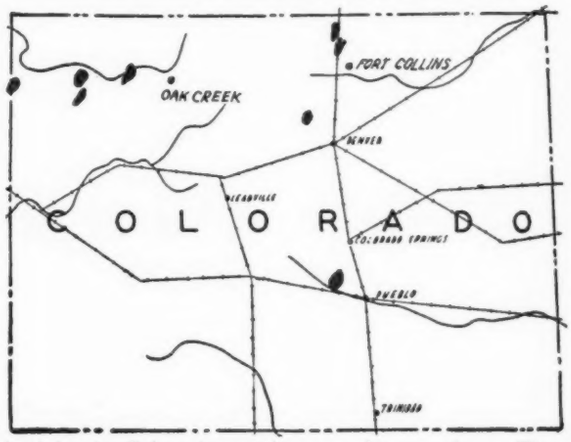
Production, 1929—3,926,630 Barrels



Twenty-two wells were completed in Wyoming last month. A late check on the state shows 25 rigs and 74 drilling wells. Both rotary and cable tools are in use in the state.

COLORADO

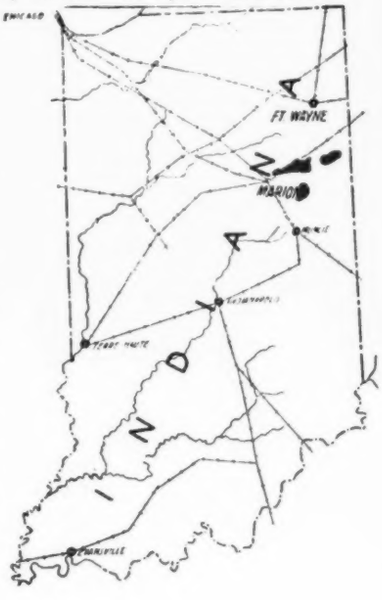
Production, 1929—2,372,100 Barrels



Activity in Colorado continues to be very low. The past 30 days show the completion of only five wells. The state has 13 rigs and 80 drilling wells. Rotary tools are used on the deeper tests, with cable tools on the shallower wells. Extreme cold temperatures and heavy snows are already affecting the operations of the state.

INDIANA

Production, 1929—977,000 Barrels



Operations in Indiana continue to rock along at about the same clip. There were a total of 24 completions, 4 rigs and 42 drilling wells last month. With shallow producing horizons and no hard drilling problems operators depend entirely on cable tools for drilling. No increase in operations is anticipated for this state at any time in the near future.

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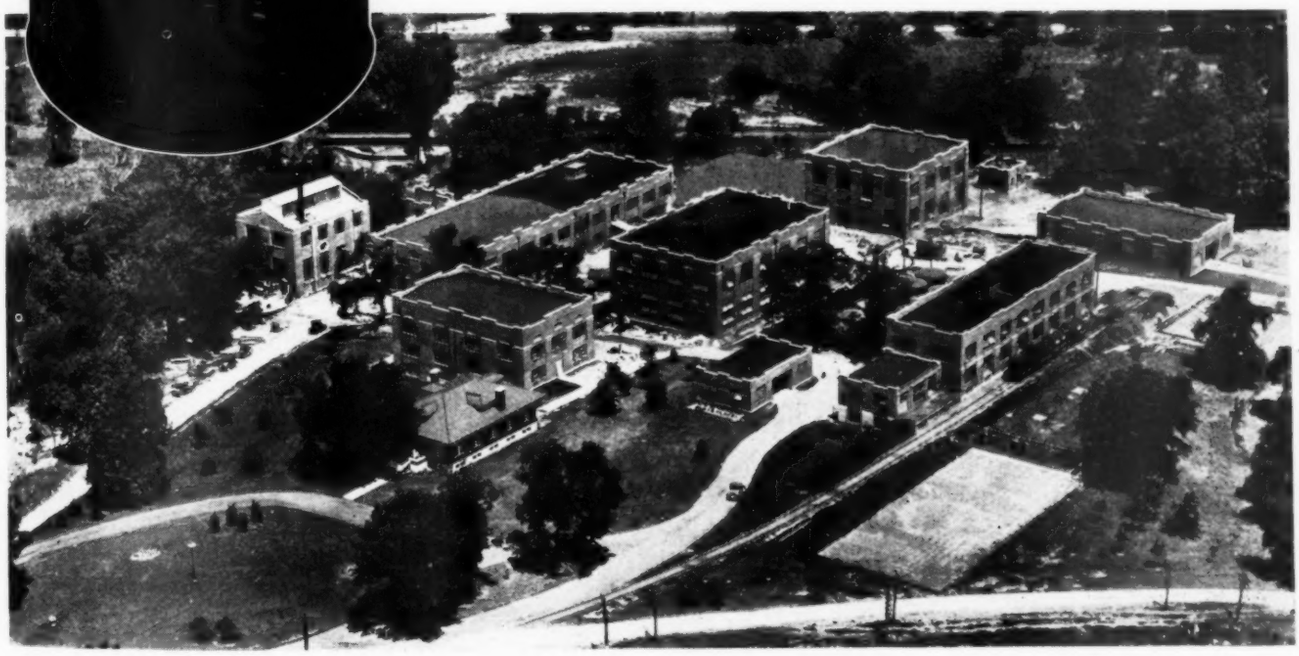

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Progress of Major Pipe Line Work

GREAT LAKES PIPE LINE CO.

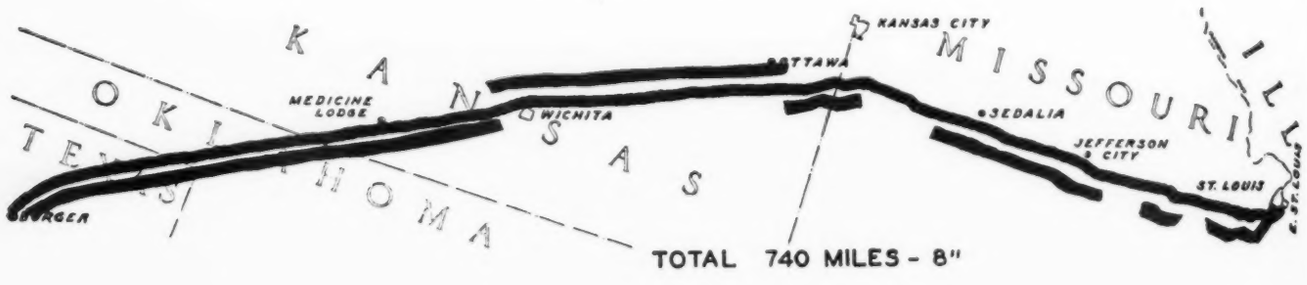
RACING just ahead of cold rains and wintry weather which is impeding line construction progress in the northern states, two major pipe lines started in 1930 crossed the finish line before the first siege of subzero weather arrived. In the southern tier of states, which are not troubled greatly with cold weather but frequently with rains, one other major project has been completed and another farther north is rapidly nearing completion.

Great Lakes Pipe Line Co., builders of a 1,440-mile gasoline artery reaching into the Great Lakes region, is well under way with construction of its welded 8-inch and six-inch line, with approximately 500 miles of pipe in the ground. Most of the remaining construction, however, is in the "cold area." The four initial stations from Barnsdall to Kansas City, Mo., are about 50 per cent complete and work has been started on station No. 5, north of Kansas City.

On the southern end of the line Sheehan Pipe Line Construction Co. has almost completed its section of 8-inch line from Barnsdall to Kansas City, and all of the river crossings on that section were built several weeks ago. Natural Gas Engineering Corporation is running on schedule in the construction of the 8-inch section from Kansas City north to Des Moines, Iowa, and Schmit Construction Co. is well along with its section of 6-inch from Des Moines to Minneapolis, the northern terminal.

Cater Construction Co. is on the down grade of nearing completion of construction of its 6-inch section running east from Des Moines to the Mississippi river, and Seybold and Mitchell, contractors building the 6-inch section east from the river to Chicago, have finished the river crossing and are building east.

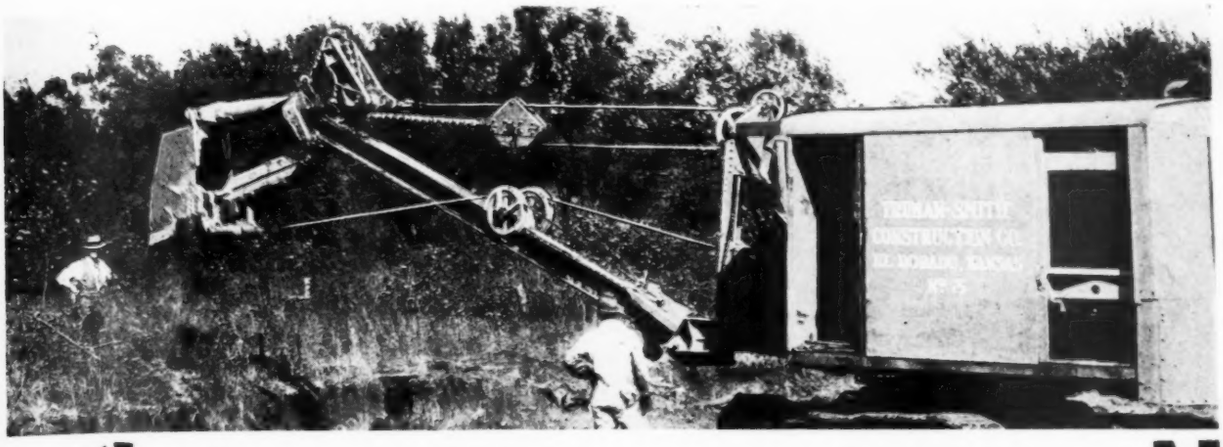
PHILLIPS PIPE LINE CO.



Line construction of the Phillips Pipe Line Co., builders of the 8-inch welded line from the Texas Panhandle to St. Louis, and which was awarded to Kelly-Dempsey & Co., is in a position to be completed somewhere near the first of the year. All of the river and stream crossings have been completed and only the gaps on the east end in Missouri remain to be closed in. The gangs are completing the line at the rate of a little more than eight miles daily.

Station construction has been delayed to some extent, but with favorable weather it is expected the line will be in operation by February 1. Gasoline will probably be pumped from the Panhandle to Wichita, Kan., by the first of the year. It will be recalled the stations on this line will have centrifugal pumps driven by gas engines through gear increasers. Fuel gas will be obtained by vaporizing butane, which will be pumped through the line as a liquid.

Indicates completed portion of line.
Indicates proposed route of line.



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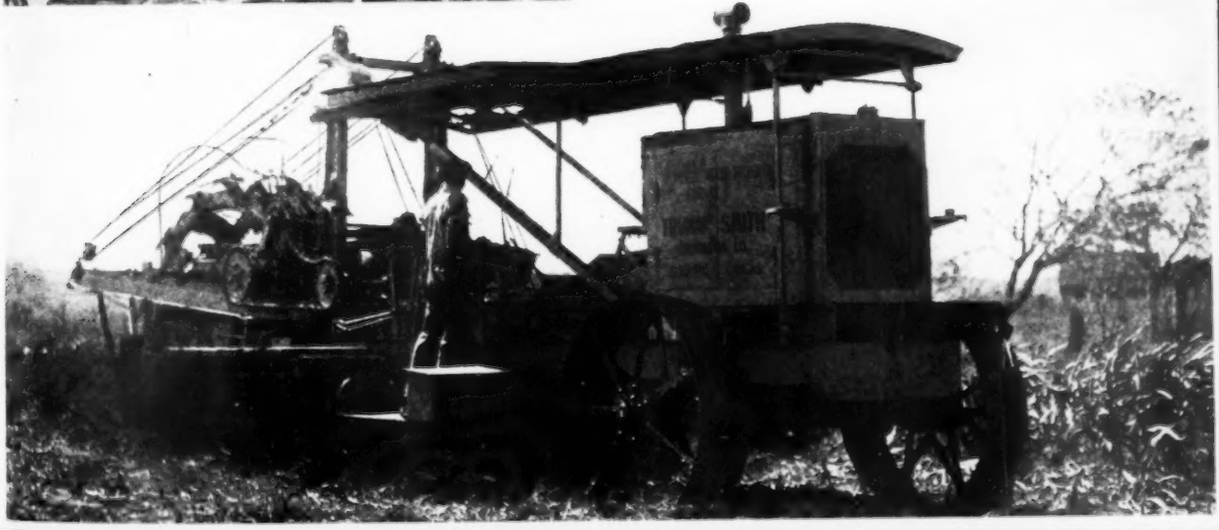

The TRUMAN-SMITH CONST. Co.

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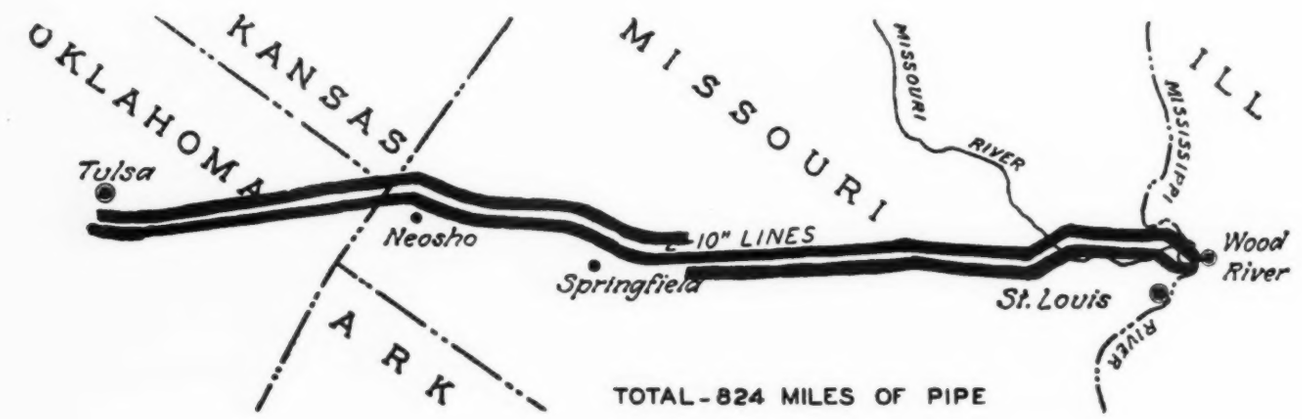
GULF PIPE LINE CO.

Gulf Pipe Line Co. of Pennsylvania, builders of a 10-inch welded oil line running from Jenks, Okla., to a point near Spencerville, Ohio, where the line makes connections with an eastern line, will be completed about the middle of December. Construction work on the 760 miles of main line has progressed rapidly since the middle of the summer, when the line was started. With the exception of a relatively few miles in Indiana, the trunk system is complete. An 8-inch lateral is to be built from a point in Indiana to Cincinnati, Ohio.

The line is filled with oil as far east as stations in Illinois and, barring unforeseen difficulties, the completed stations will be operating on a 24-hour schedule the latter part of December. The station's reciprocating pumps are powered with Diesel engines.

AJAX PIPE LINE CO.

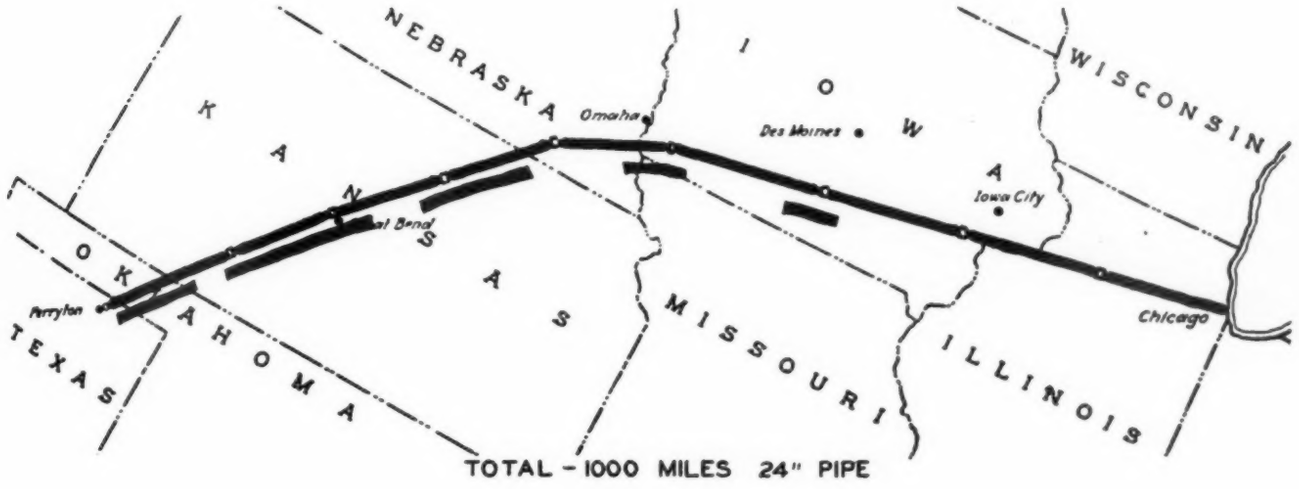


Winding up construction work with a sustained drive, the Oklahoma Contracting Co. completed the Ajax Pipe Line Co.'s double 10-inch line from Glenn Pool, Okla., to Wood River, Ill., a distance of 400 miles, in slightly less than five months. And while the construction crews were making an enviable record, the Ajax engineering department had its station construction program accelerated to a similar speed.

The contractors started stringing pipe on June 26 and on the afternoon of November 25 the last section of No. 2 line was tied in. Once the station construction program was under way, it progressed rapidly. The stations are powered with three 500-horsepower Diesels driving reciprocating pumps, two working on the line and the third is a reserve unit.

Indicates completed portion of line.
Indicates proposed route of line.

CONTINENTAL CONSTRUCTION CORP.



Continental Construction Corporation, designers and builders of the 24-inch combination welded and coupled gas transmission system from the Texas Panhandle to Chicago, Ill., has construction work progressing in four states. Four contractors—Sheehan Pipe Line Construction Co.; Ford, Bacon & Davis, Inc.; Bechtel-Kaiser Co., Ltd., and Henry L. Lemons, Inc.—have thus far been awarded contracts to build sections of the 1,000-mile system. Most of the construction work is behind the contractors in Kansas and the comparatively short sections in Texas and Oklahoma have been completed.

PANHANDLE-EASTERN PIPE LINE CO.

Panhandle Eastern Pipe Line Co., formerly Missouri-Kansas Pipe Line Co., is rapidly closing the gaps in building its 24-inch, 22-inch and 20-inch combination welded and coupled gas line running from the Texas Panhandle to Indianapolis. The line from the Panhandle to the Illinois line will be operated under the name of Panhandle Eastern, and from the Illinois line on east as the Panhandle Illinois Pipe Line Co.

All of the 24-inch line is being coupled and the 22-inch is being built by welding three joints and then putting in a coupling. Three contractors—Williams Brothers, Oklahoma Contracting Co. and Connor & Son—were awarded contracts to build seven sections of the line. Two compressor stations are under construction—a 5,000-horsepower compressor station at Liberal, Kan., and a 4,000-horsepower plant at Louisburg, Kan.

Indicates completed portion of line.
Indicates proposed route of line.

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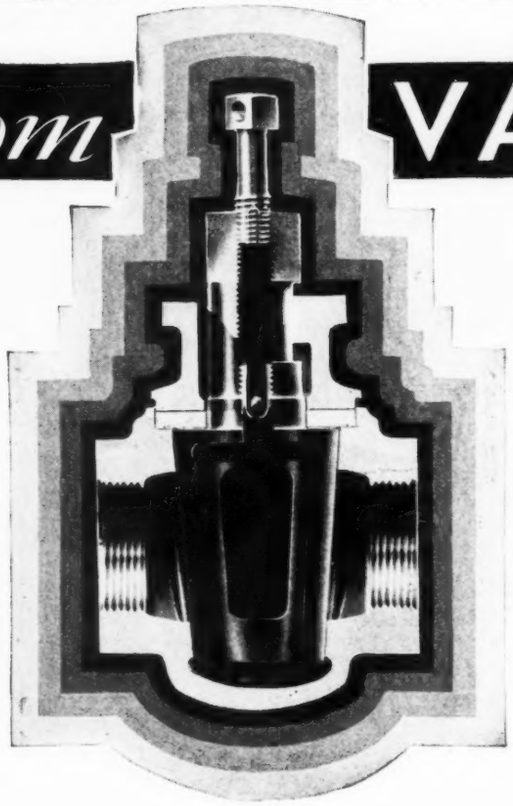

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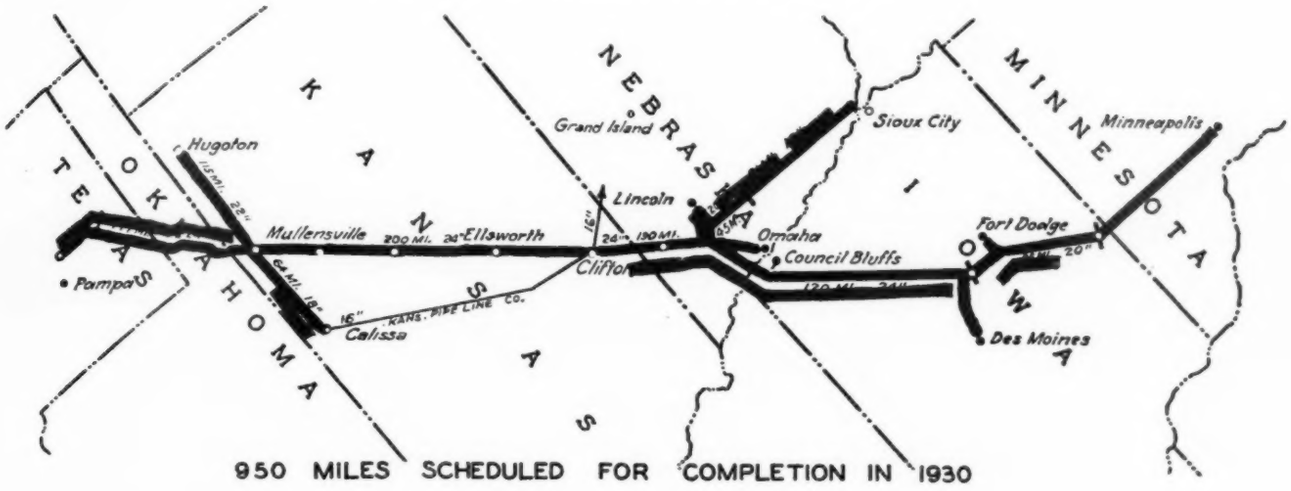
MISSOURI VALLEY PIPE LINE CO.



Missouri Valley Pipe Line Co. expects to wind up its main line construction program about the middle of November. The company had 932 miles of main and branch line construction scheduled for completion in 1930 and has more than 750 miles of this completed.

A 200-mile 24-inch gap was left open between Mullensville and Clifton in Kansas and the Kansas Pipe Line system line will be used to move gas north to Clifton. Most of the gathering system in the Texas Panhandle has been completed and construction work on compressor stations is moving along rapidly.

SOUTHERN NATURAL GAS CORP.

Southern Natural Gas Corporation wound up its 710 miles of main line extension work in the southern states early in December when a 60-mile, 12-inch extension was completed from Mobile to Pensacola, Fla., which, incidentally, will mark the first use of natural gas in Florida.

This 60-mile extension was built under extremely difficult conditions, going through virtually all swamp country. Construction of compressor stations in connection with the extension work had progressed satisfactorily. All of the new units installed are ready for service and the remaining work resolves to closing in loose ends and cleaning and painting.

Indicates completed portion of line.
Indicates proposed route of line.

Braun
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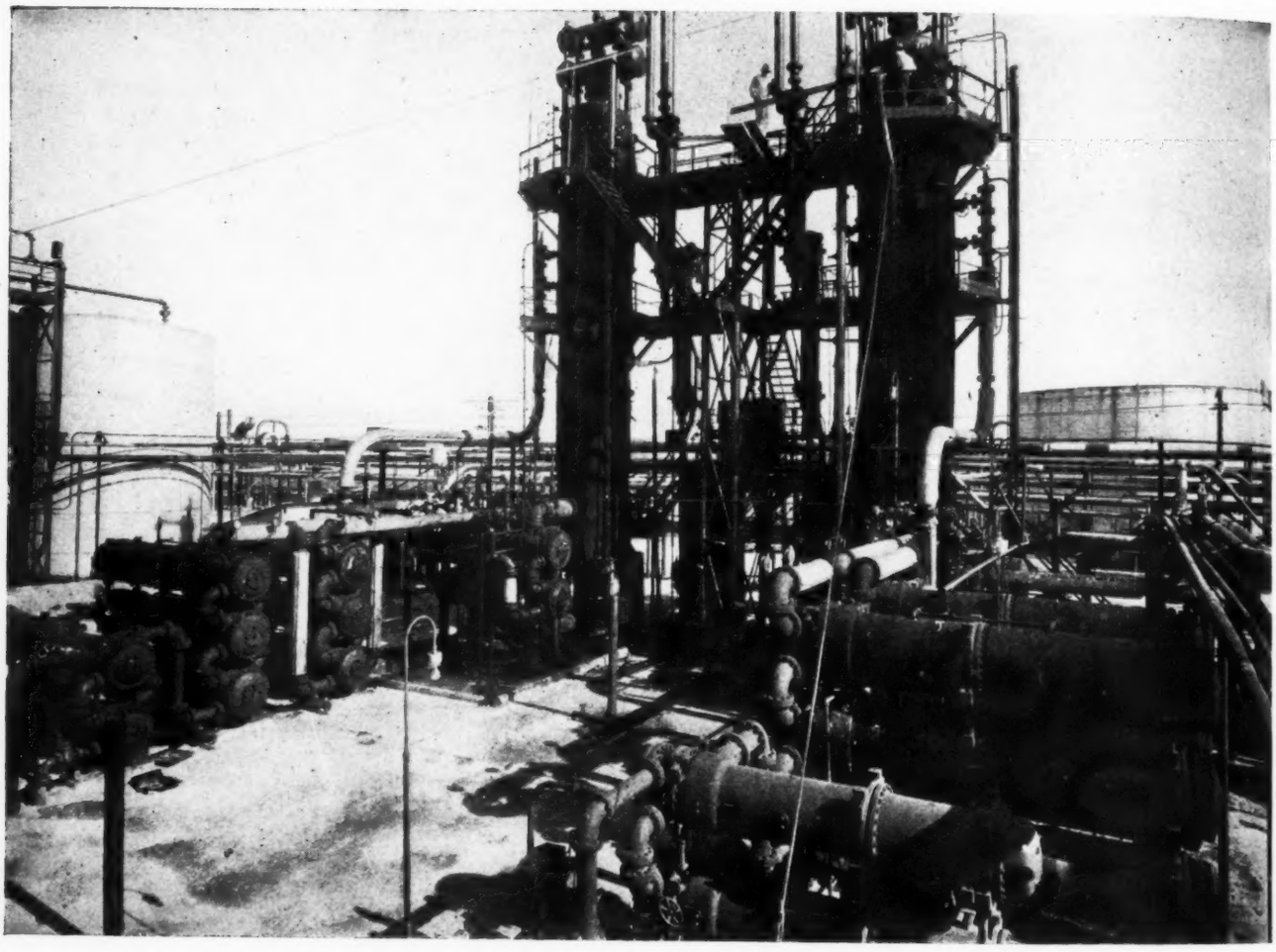

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The Month's Activities *in* Refining*

By F. R. STALEY

THE application of hydrogenation to oil refining is undoubtedly the most important technical development in the industry during the past year. The first large-scale plant in the country was put into operation this summer in the Bayway (N. J.) refinery of the Standard Oil Company. Two interesting papers were presented recently on the subject by Doctors Haslam and Russell, the first one before the American Chemical Society meeting in Cincinnati and the second before the American Petroleum Institute meeting in Chicago. The authors outline the following characteristics of the hydrogenation process:

1. Low-grade, low-value materials can be used advantageously as charging stocks.

2. The products from these low-grade charging stocks are uniformly of exceptionally high quality and usually of premium grade.

3. Whether the process is operated to convert fuel oil residues to gas oil and gasoline, to make distillates more paraffinic, or to make non-paraffinic anti-knock gasoline, the products are stable and low in sulfur.

4. The single operation of hydrogenation usually accomplishes results obtainable at best only by the use of at least two operations of present-day refinery practice, as, for example: 1, cracking and acid treatment; or, 2, cracking, acid treatment, and the addition of casinghead.

On account of the great increase in demand for anti-knock gasoline, many new cracking units have been installed. The new Toledo refinery of the Pure Oil Company will consist entirely of Gyro vapor phase units. The refiners of Pennsylvania crude are building several cracking units. The Pennzoil Company at Oil City is erecting a 2500-barrel cracking unit. The Associated Oil Company will build a 10,000-barrel cracking unit at its Avon refinery on San Francisco Bay.

The Marathon Oil Company recently purchased the Del Rio refinery. This is essentially a topping plant and processes Pecos crude. The products include a straight-run anti-knock gasoline and a lubricating distillate.

The Mex-Cal Oil Refining Company will build a small refinery at Terra Bella to manufacture lubricants exclusively.

Refinery operation in the past month showed a small decrease over the previous month. The eastern refineries dropped from 76.1 per cent to 70.6 per cent, and the central refineries from 69.7 to 65.7. Refinery operation in the western division showed practically no change.

Natural Gasoline

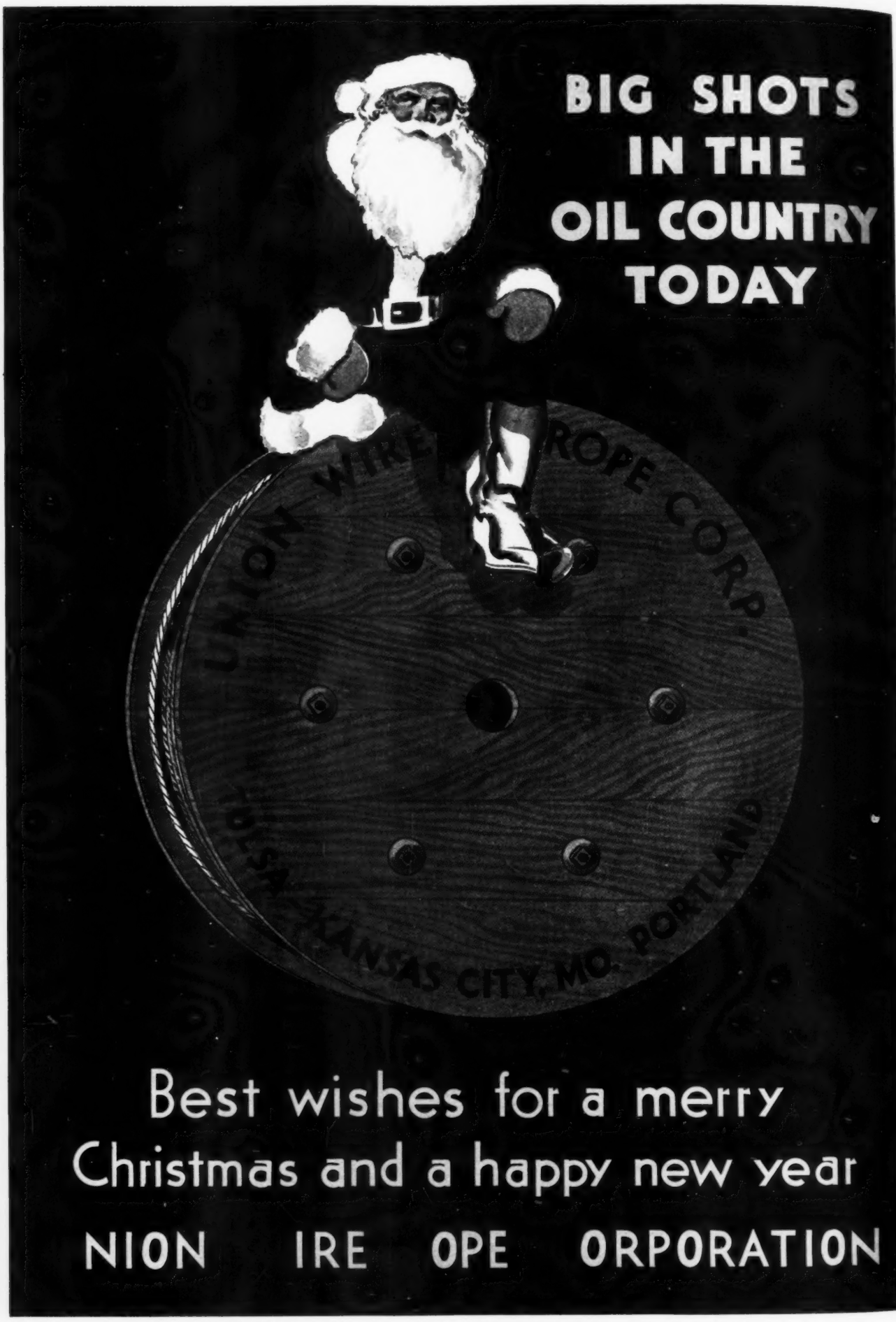
The Utilities Gas and Electric Company of Chicago will construct twelve butane gas plants. The butane will be manufactured by the Skelly Oil Company.

The Standard Gasoline Company will construct a rectifying unit in its No. 2 plant in the Avenue field, California.

The Empire Companies are building two new natural gasoline plants. One plant will be built in southern Seminole County in the Konawa area and the second one will be built four miles southwest of Pampa, Texas. These two plants will make a total of twenty gasoline plants for the Empire Companies.

Figures in red show per cent refining capacity operated.

*All statistics as of December 1st.



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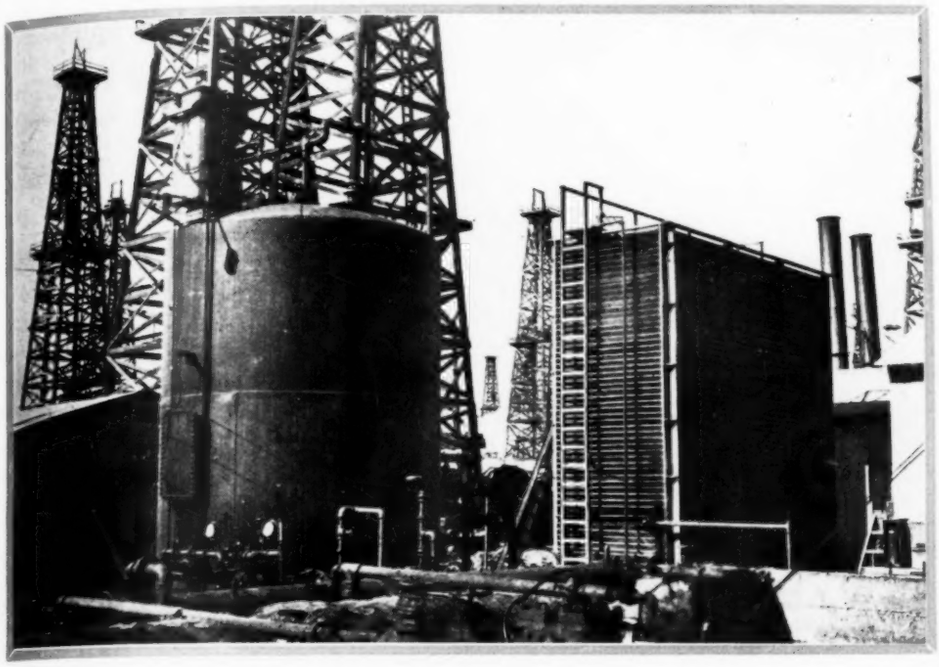


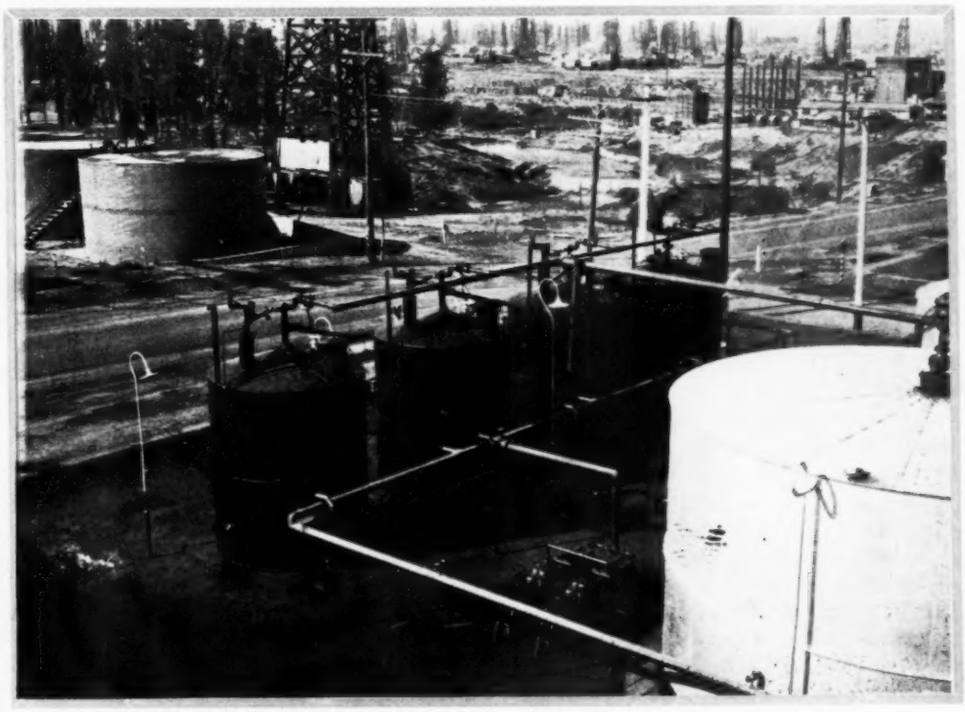
An electric dehydrator in the Signal Hill Field, California. The treated oil is cooled in the tower on the right.

Electrical Dehydration Keeps Pace with Progress in California

By W. A. SAWDON, *Petroleum Engineer, Los Angeles*

THE dehydration of cut oil presents a problem in every field where such oil is produced. It is a problem that must be solved and requires a study of the emulsion from each producing zone—and sometimes from the individual wells in that zone—in order to arrive at the best treating method to use. The electrical process has been employed successfully in various parts of the country for many years; but recent developments have shown its adaptability to changing operating conditions. In California, the variety of new conditions has added to the interest given this method of treating cut oil.

A discussion of emulsions and the various methods of treating them is not here necessary since the subject has been well covered and deserves a thorough study by all who are interested in the production of oil.[1] It must be emphasized, however, that different emulsions give different reactions to treatment and that their character must be considered when planning a treating plant. Some few cut oils will de-emulsify when merely allowed to stand; others will do the same when heated; but the vast majority require treatments which vary with the tightness and other characteristics of the emulsion. Electrical dehydration, therefore, has had to be flexible to handle all the different kinds of emulsions and has had to be adaptable to adjustment to meet the conditions arising



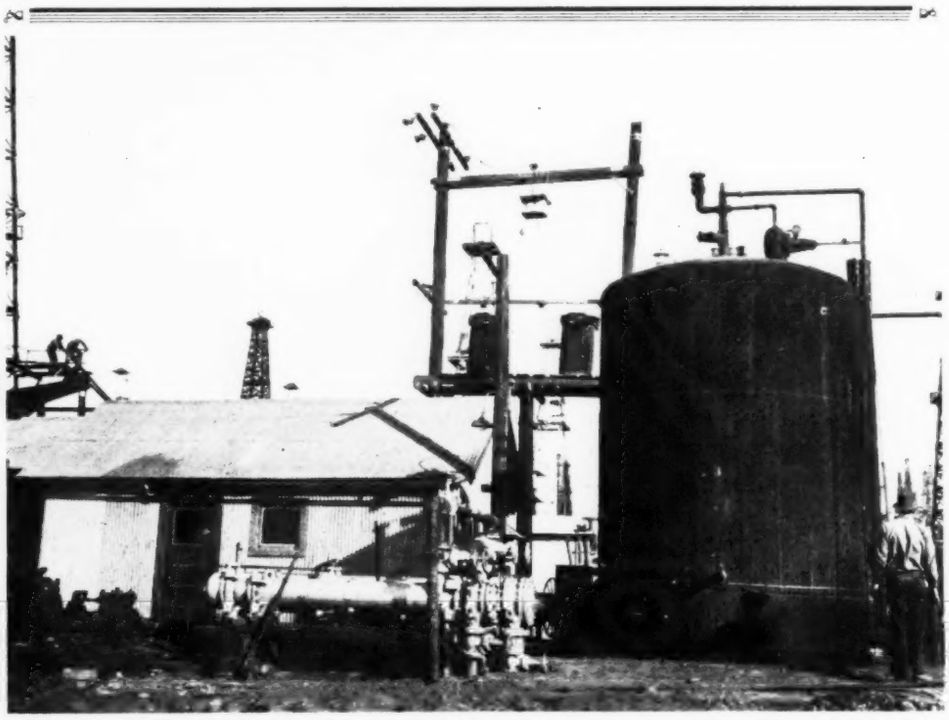
Four of the eight dehydrators at a pipe line central treating plant at Long Beach, Calif.

[1]Among the many valuable treatises on oil field emulsions are U. S. Bureau of Mines Bulletin No. 250 by D. B. Dow and "The Theory of Emulsions and Their Technical Treatment," by William Clayton. The principles of de-emulsification by electricity have been explained in detail by W. O. and H. C. Eddy in "A Discussion of Electrical Dehydration of Crude Oil," Journal of Industrial and Engineering Chemistry, Vol. 13, No. 1, page 1016, November, 1921.

from a change in the character of the oil as the field grows older.

Deeper drilling and the use of gas lift have had an influence on the cutting of oil. In many cases they have not only increased the amount of cutting but have also increased the tightness of the emulsion. This has led to the development of a new type of electric dehydrator that will include the handling of these emulsions efficiently. It is designed to obtain a better utilization of the electric field and involves a change in the manner in which the cut oil is introduced. A desired higher voltage is gained inside the shell by using two transformers and two separately insulated connections through the shell to the electrodes.

The principle of electrical dehydration naturally remains the same. When an emulsion of oil and water are placed in a high potential alternating electric field, the small particles of water become electrically charged and rupture the films of oil that envelop them. The drops of water then coalesce and progressively form larger drops until they reach a size sufficiently large to settle out. To quote from Eddy and Eddy, it is found that "This action of stress and strain, attraction and repulsion, on the conducting water particles continues until all the microscopic drops of water in the original emulsions have broken the bonds of the entrapping oil films, the larger droplets serving as nuclei until the entire water content is freed into large drops which readily settle out. The low power requirements of the process, from the records of commercial plants, substantiate the theory that the phenomenon is that of a multitude of series condensers rather than of conducting paths. The minute water particles serve as electrodes or poles of the condensers, and the separating oil acts as the dielectric which is ruptured by the high voltage, allowing adjacent positively and negatively charged droplets to neutralize themselves by uniting."



Heat exchangers are used in this installation to lower the temperature of the oil after leaving the dehydrator.

The electric dehydrator consists mainly of a vapor-tight shell in which are located a live and a grounded electrode. The untreated or "wet" oil is introduced into this and flows directly into the electric field between the electrodes. It is here broken up into its separate oil and water contents. The water settles down to the bottom where it is drawn off; the oil passes upward and flows out the top to the stock tank. The voltage carried in the tank is from 11,000 up and is governed by the operating conditions. It is stepped up from the field voltage by means of transformers placed on the dehydrator. An automatic circuit breaker (which closes the circuit only when the oil level is above the top of the dehydrator) eliminates all hazards due to the ignition of oil vapors that might occur with the presence of air within the tank.

The use of heat, agitation, the regulation of water level, the distance between electrodes and the voltage are all factors depending upon the character of the oil, the emulsion and the operating conditions. A laboratory test of the cut oil will usually determine all these before an installation is completed but experimentation in the field can be used if desired. Adjustments to maintain the highest efficiency can also be based on tests and plant operation can be greatly facilitated by the proper attention to changing conditions.

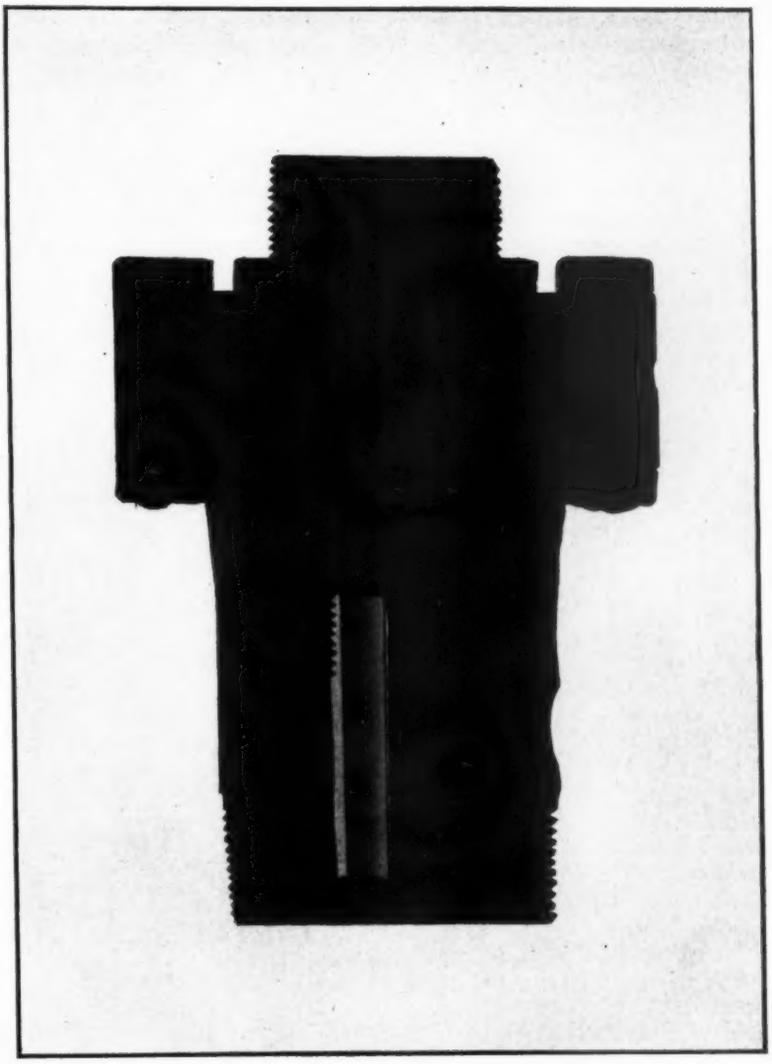
The heating of the cut oil by a preheater before it enters the dehydrator is usually done to accelerate the settling of the water after the emulsion has been broken up. This increases the capacity of the plant since electrical dehydration is a continuous operation and is influenced by the speed at which the fluid passes through it. Heat lowers viscosity and this is also advantageous. The general run of cut oil requires a temperature of about 130 degrees F. Some oils, of course, require no heat at all while others require more. In the Signal Hill field the wells on gas lift frequently make a very tight emulsion and the temperatures there are sometimes carried up to 190 degrees F.

Agitation is sometimes necessary to bring fresh material between the electrodes and to eliminate short circuits. This is accomplished by moving the live electrode in a vertical direction with a travel of never more than three-quarters of an inch. A motor with a crank and walking-beam is used to accomplish this. Many oils require no agitation. The distance between the electrodes is usually determined before the installation is made but it can be adjusted if changing conditions make it desirable. Sometimes the voltage is changed to give the same results.

In putting the dehydrator into service, all water should be drained off before the cut oil to be treated is turned into it. Except for heating, no other preparation is necessary. The water level during operation should be kept at a position which experience will determine is giving the best results.

Since one of the advantages of electrical dehydration is the prevention of losses to both volume and gravity through evaporation, the treated oil is cooled after leaving

THE NEW REGAN ADJUSTABLE TYPE TUBING HEADS



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the dehydrator. This is usually done by the use of heat exchangers or by cooling towers. The temperature of the cut oil before entering the preheater (if one is used) will naturally influence this since an oil coming from the well with a high temperature will be of little value in cooling the treated oil in a heat exchanger. This is especially true where the temperature of the treated oil is comparatively low. In the Elwood field the locations facilitate cooling since the dehydrated oil is run through coils placed in the ocean. In congested districts where cooling towers are desirable, one tower can be built for several wells and the treated oil from the several dehydrators can be cooled at the one location.

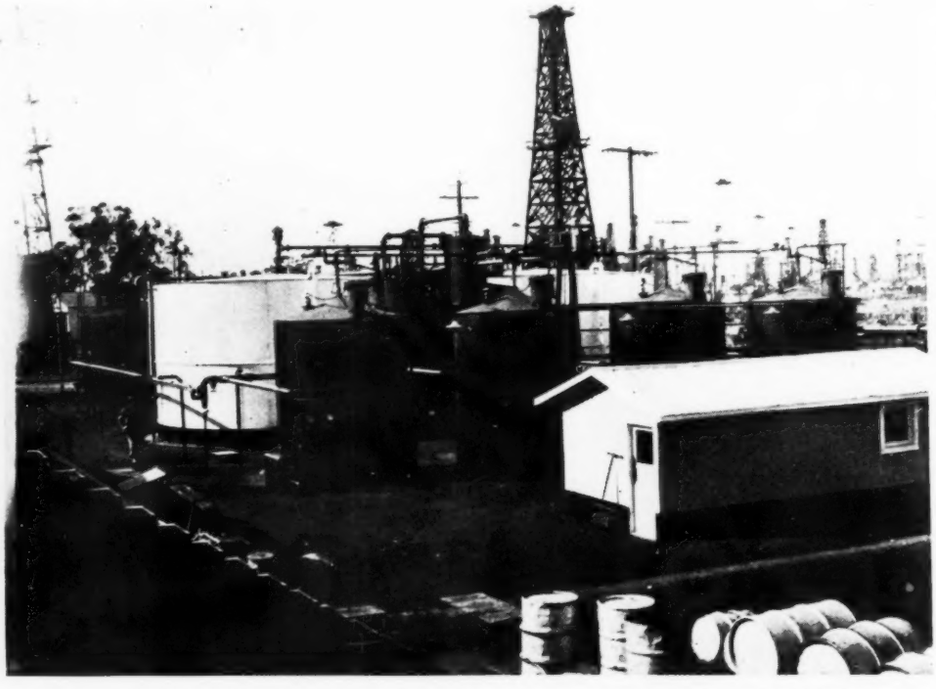
Electrical dehydration has been used successfully in California fields for treating the production from one well, from a group of wells or a lease, for the combined production from a field and for the production from a number of fields at one central location. The central plant handling all of a company's output from a field or from several fields offers many economic advantages when it is possible to combine the oil from the various sources. Several units must, of course, be provided for this kind of installation but this is also advantageous since a dehydrator can be transferred to another locality if its use is no longer necessary to handle a declining volume of oil.

The operation of a central plant may be under the production department or the pipe line department. The one shown in the illustrations is a pipe line operation and the treated oil is put into the pipeline system as soon as it comes from the dehydrators. The plant is located in the Long Beach field and takes all the company's production from that field. Oil is received with an average emulsion of about 35 per cent and is cleaned to slightly less than 1 per cent B. S. and water. After treatment, the clean oil is cooled through heat exchangers to 90 degrees F. The temperature at which the oil enters the dehydrators is maintained at 170 degrees F., being heated to 152 degrees F. by an exhaust-steam heat exchanger before entering the preheaters located at the dehydrators.

One company treats its production from all the fields in the Los Angeles basin at an electrical dehydration plant located at its refinery just south of the city of Los Angeles. Sixteen units have been used here and over 50,000 barrels of net oil per day have passed through the plant. At present, proration has lowered this to a considerable extent and only a portion of the dehydration plant is now in service.

A single unit is generally used for treating the oil from one lease or, as in the case of town lot production, from one well. The quantity of cut oil to be treated naturally governs that. All electrical dehydrator units are made of standard size. Each has a volumetric capacity of about 180 barrels, but the amount of net oil that can be treated will vary with the amount of emulsion, its character and other factors. As high as 6,000 barrels per day have been treated by a single unit, but this is an exceptional case. From 1,000 to 1,500 barrels is probably the present average amount. Many large leases, therefore, may require more than one unit, while some will never tax the capacity of one unit. It has been deemed advisable to make the units of one size since additional ones can always be added to take care of large production and can be moved to other locations when they are no longer needed.

The smallest production that should be treated electrically naturally presents an economic problem. It will be governed to a great extent by the character of the oil. In many cases where gravity can be increased and a higher price obtained, a production of even less than 100 barrels per day might be dehydrated electrically and an increased revenue obtained. Operating conditions will also be influential and labor employed for other purposes may be made to include plant operation. The space required for electrical dehydration is small and many units are in service on the town lots of Venice, Signal Hill, Santa Fe Springs and Huntington Beach. In one case the dehydrator is located at the well, a cooling tower for the treated oil is across the highway, and the stock tank is down a hill several hundred feet away.



The house in the right foreground contains the electric controls for the eight electric dehydrating units at the central plant.

In the latest producing zone in the Signal Hill field the percentage of cut oil ranges from 10 per cent to 60 per cent with even offset wells sometimes approaching those limits. The tightness of the emulsions also varies to a considerable extent in the production from two adjacent wells. In some of the California fields, many similar variations occur while in others the percentage and tightness may be approximately the same for all the wells. Individual treatment and study is therefore necessary when planning a dehydration plant. The electrical process has certain features that are advantageous, yet it cannot be blindly installed.

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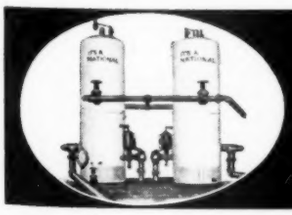

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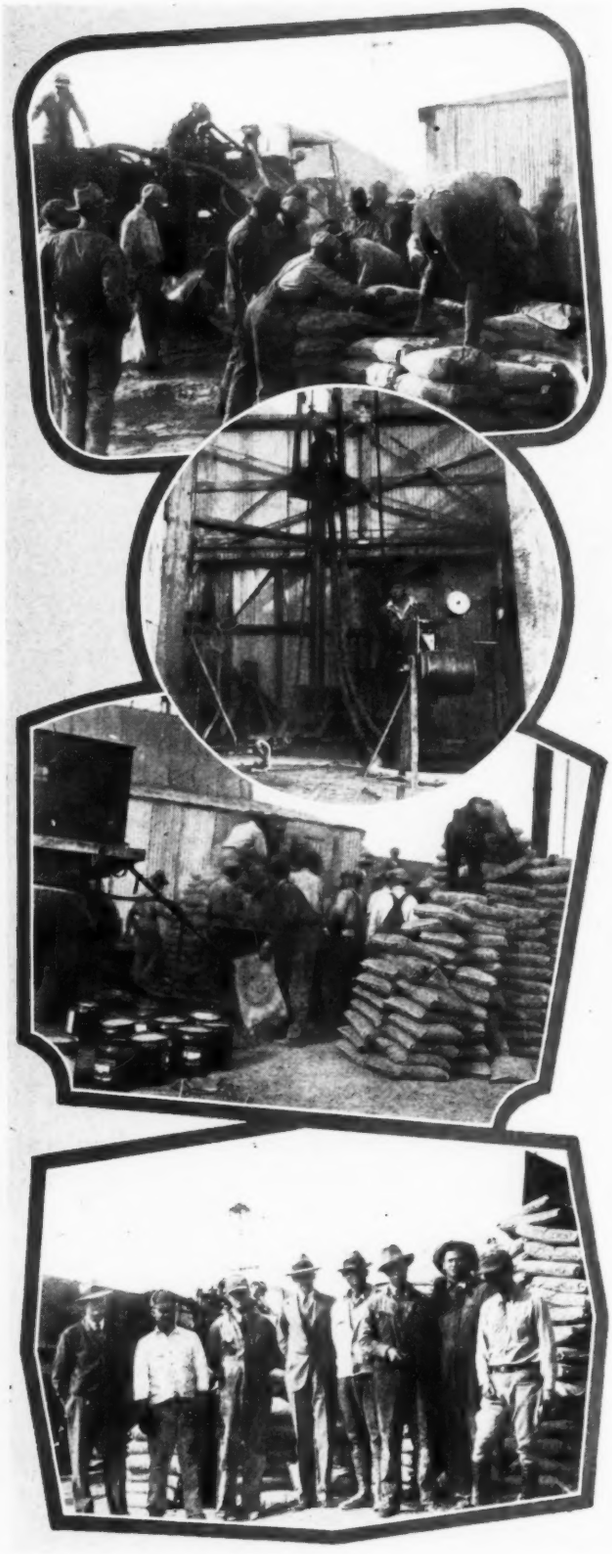
Cementing *a* Long String *of* Casing *in* Record Time



SO accustomed have they become to deep development operations in the Big Lake field, Texas, that the most difficult deep jobs on wells are tackled in a most unobtrusive manner.

An example of this was furnished recently when a string of 7-inch, 28-pound casing, a mile and a half long—or, to be exact, 8036 feet—weighing approximately one hundred and twelve and one-half tons, was landed and cemented in the remarkably short time of 14 hours. This was on the Big Lake Oil Company's 5-C, which is being drilled by the Loffland Brothers Company, drilling contractors, of Tulsa, Okla. The actual time it took to run the tubing was approximately 13 hours. Two cement float plugs were used to float the string of casing in the hole. When the last few joints of casing of the 8036-foot string were added, the casing handled as freely as though only a few joints of casing were in the hole. Save for the extreme care used in lowering the casing, there was not much in evidence to indicate that an extremely long string of casing was being handled.

A record was established in placing the cement. Two Halliburton cementing outfits stood by, ready to start the cement into the well just as soon as all the casing was in the hole. This was on Friday, November 21, 1930. At 3:50 p. m. everything was in readiness and promptly pumping of the cement down the casing started. Twenty minutes later all of the cement plug—1000 sacks—was in the casing on its mile-and-half trip to the bottom. Mixing and pumping cement at the rate of 50 sacks per minute was maintained.

By the time the Halliburton line was run in the well the top of the plug had traveled to between 4000 and 5000 feet down the casing. By 4:55 p. m., one hour and five minutes from the beginning of the cementing operation, the job was completed. During the last 15 minutes the pumps forcing the plug down the casing labored heavily, at times almost stopping. The final estimated pressure on the pumps when shut down was 2200 pounds per square inch.

Two Halliburton cementing outfits were used in order to expedite the placing of the cement. A crew of about 20 men from the Big Lake Oil Company handled the dumping of the cement into the mixing hoppers. The accompanying photographs were taken while this work was in progress.

The cementing job was done under the direct supervision of I. B. Cate, assistant superintendent at Odessa, Texas, for the Halliburton Cementing Company. Cecil Rains, toolpusher for Loffland Brothers Company, is in charge of the drilling of this well, and to him much of the credit is due for landing the long string of casing.

Top to bottom—Mixing and pumping cement at average rate of 50 sacks a minute and cementing in 7-inch casing, Santa Rita 5-C, Big Lake Oil Co., Big Lake field. Pumping in cement, Santa Rita 5-C, Big Lake Oil Co., Big Lake field. Two Halliburton well-cementing outfits used in cementing Santa Rita 5-C, Big Lake Oil Co., Big Lake field. Picture was taken just as cementing operations were started. Halliburton Cementing Company men on the job when an 8036-foot string of 7-inch casing was cemented in Santa Rita 5-C, Big Lake field, with 1000 sacks of cement in 22 minutes. Left to right: Jay Taylor, superintendent; R. G. Kelly, driver; Raymond Massey, cementer; C. P. Parsons, field engineer; H. Phillips, cementer; Guy Jones, cementer; Dick Hendricks, driver, and I. B. Cate, assistant superintendent.

The Dynamometer an Aid in
Correcting Well Pumping Troubles

By HAROLD DECKER,
Petroleum Engineer, Skelly Oil Company

WITHIN the past few years, the industry as a whole has devoted considerable time and research to well pumping problems. Completion depths are ever on the increase, and deep wells today are drilled with the knowledge that eventually they will present formidable pumping problems. Despite the fact that deep wells offer difficult pumping problems, pumping troubles are more easily segregated than formerly—hence more easily remedied—as a result of the use of the dynamometer in this field. This instrument has already proven to be an invaluable aid in not only correcting pumping troubles, but also in furnishing helpful information regarding well operation.

Harold Decker

Illustrated in Fig. 1 are cards taken on a 4,400-foot well located in the Earlsboro, Oklahoma, field. Card "A" was taken when a 2½-inch insert pump was in use in the well. The cup size was 1 15/16-inch. From the appearance of the card and the way the well was pumping, the cups had entirely too tight a fit in the pump barrel. This well was giving considerable rod as well as pump trouble. After changing the size cups to 1 29/32-inch, 1/32 of an inch smaller than previously, the diagram on card "B" was taken. It can be seen that the maximum load was reduced from 18,800 pounds to 16,000 pounds at the same speed. Card "B" shows freer plunger travel, and the well pumped considerably more fluid. The well was then counterbalanced and the card "C" indicates how the well was operating when this work was completed. With smaller cups and the well properly counterbalanced, not only was more fluid produced, but practically all down time was eliminated as well.

A wide variation in the number of revolutions per minute is found in gas engines when the well is not properly counterbalanced. This can readily be remedied by proper counterbalancing and will greatly improve not only the life of the gas engine but all other equipment as well. The figures presented in Table 1 clearly illustrate this point.

TABLE 1.

Showing Effect of Counterbalancing on Gas Engine Speed. (Gas Engine Speeds Were Taken With an Indicating Tachometer.)

	Before Counterbalancing				After Counterbalancing			
Well	Strokes Per Min.	Maximum R.P.M.	Minimum R.P.M.	Variation	Strokes Per Min.	Maximum R.P.M.	Minimum R.P.M.	Variation
A.....	22	170	135	35	22	162	144	18
B.....	22	200	150	50	23	215	180	35

An interesting observation was made while obtaining the variation in well speeds with the tachometer. Before counterbalancing, the pump speed varied from 14 to 21 strokes per minute; after counterbalancing at the same average speed the pump speed varied only from 18 to 21 strokes per minute, indicating a reduction in speed variation with proper counterbalancing.

Figure 2 illustrates the effect that speed and length of stroke have on plunger travel and pump efficiency. Card "A" was obtained on this well, running 22 strokes per minute on a 47-inch stroke. Under these conditions, a rod break had occurred on an average once every six days, and with four different makes of rods. The life of a string of rods was from 35 to 80 days. A grasshopper type counterbalance was in use. Card "B" shows the results of changing the effective counterbalance weight from 4,000 pounds to 6,200 pounds, the speed from 22 to 28 S. P. M. and the length of stroke from 47 to 37 inches. That is, previous to any change, the polished rod travel was 22 times 47, or 1,034 feet per minute, and after the change, 28 times 37 or 1,036 feet per minute. With an increase of only 2 feet of polished rod travel per minute, the total fluid on this well increased from 209 barrels to 286 barrels. The oil increased from 62 to 86 barrels. This illustrates that in this case, with a short fast stroke, undoubtedly greater plunger travel was obtained than formerly, in order to be able to produce 75 barrels more fluid. Since this work was completed on June 20th, only 6 breaks have occurred, an average of 19 days between breaks. Also, the oil production from this well has averaged 17 barrels a day more than previous to weighing. This represents an increase, during this period, of several thousands of dollars in oil revenue, aside from the savings in labor and repairs. Continued operation at this efficiency will mean vastly increased earn-

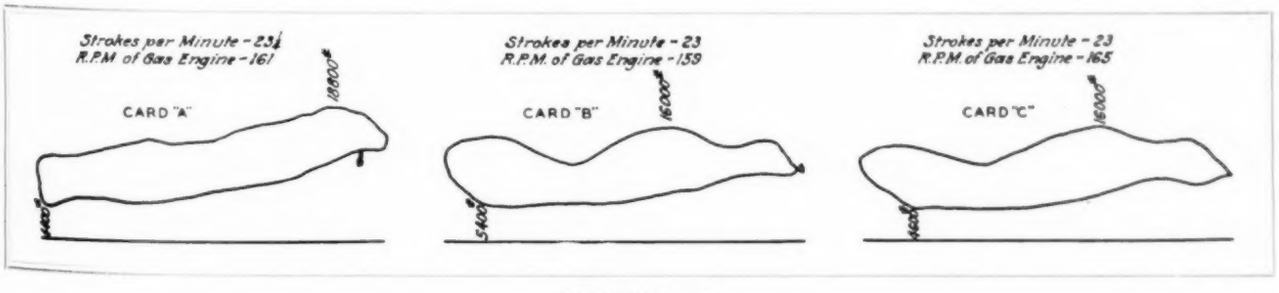


FIGURE No. 1

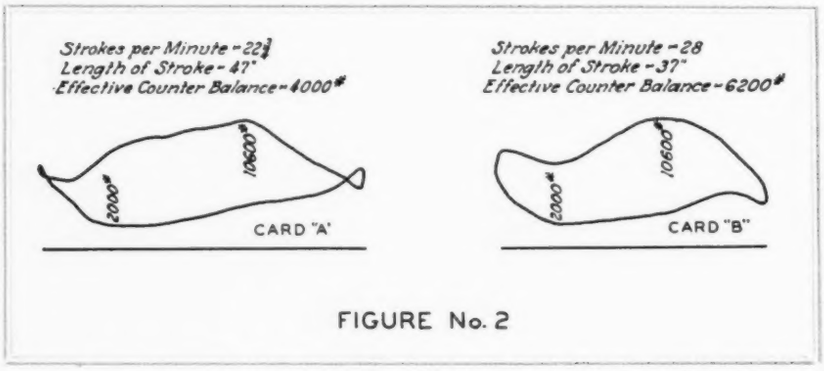


FIGURE No. 2

ings with a consequent decrease in lifting cost per barrel compared with previous operation.

Figure 3 illustrates the results of counterbalancing alone. Cards "A" and "B" were taken before and after counterbalancing respectively. This well gave improved rig and rod service after this was done.

The cards presented in Figure 4 were taken on a well in the Lovell Pool, Logan County, Oklahoma. This well is 6,036 feet deep, and when these cards were taken, was being pumped from a depth of 5,845 feet. The well was equipped with a 2½-inch insert barrel and ¾-inch sucker rods. The horse power computed from the cards was surprisingly low, ranging from 2.5 to 3.25 H. P. The well is practically flowing its production, which accounts for such low maximum loads. The weight of the rods and fluid should be 14,720 pounds, whereas, the maximum load is only 13,200 pounds to 13,800 pounds. Because of the rig setup, the well is slightly under-counterbalanced. Since these cards were taken the pump has been changed because of sanding-up troubles.

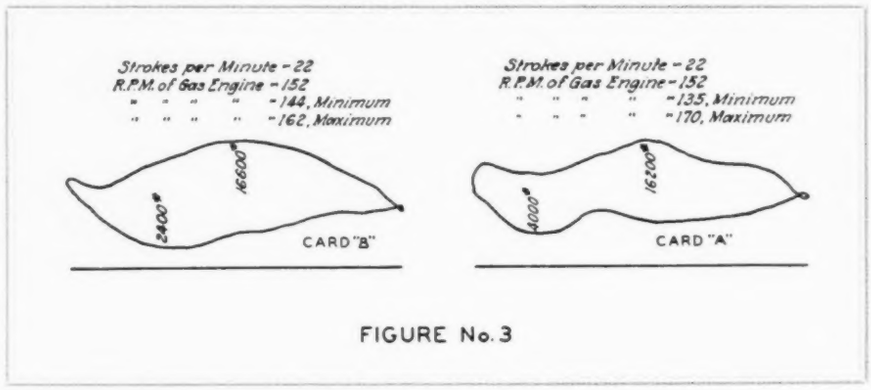

Strokes per Minute - 22
R.P.M. of Gas Engine - 152
" " " " - 144, Minimum
" " " " - 162, Maximum
16600#
2400#
CARD "B"
Strokes per Minute - 22
R.P.M. of Gas Engine - 152
" " " " - 135, Minimum
" " " " - 170, Maximum
16200#
4000#
CARD "A"

FIGURE No. 3

In order exactly to determine the point of pounding fluid in a well, the cards in Figure 5 were taken. This well pumps off in exactly one hour after it starts pumping. The cards taken at 4:25 indicate that only a small portion of the barrel filled at each stroke, pointing to the fact that the well was completely pumped off.

In counterbalancing deep wells, it has not always been practicable, because of the rig setup, to apply enough counterweights correctly to do this work. As the majority of these wells are equipped with wooden rig fronts that have short jack posts, it has not been possible to add very much weight on rotary counterbalances. Also, in using the backside rotary counterbalance it has been found that excessive strains were put in the frontside jack post and jack post bearing. Turnbuckles holding these jack posts down were continually breaking, or coming loose. While a heavy backside balance gave considerable torque to the crankshaft, there was still a good margin of safety. Also, the front side counterbalance was not always properly designed to give enough effective weight. To overcome these difficulties on the more severe wells, a double counterbalance, that is, a rotary balance on each end of the crankshaft, has been used. By using a double counterbalance, the desired effective weight can be secured, and only one-half of the load is placed on each end of the crank. Loose jack posts and broken turnbuckles were eliminated, and the whole rig not only ran smoother, but gave less trouble and stayed tighter over a longer period of time than formerly. The increased investment on the wells where the double counterbalance is used is offset by the well being properly balanced and by securing a tighter rig front. In Table 2 are given, for several makes of rotary counterbalance of approximately the same dead weight, the corresponding weight, effective weight and center of gravity. Referring to the effective weight shown in the table, it is assumed that each counterbalance was used with the wrist-pin in the fourth hole of an A. P. I. 6-inch crank.

TABLE 2.

Effective Weight and Center of Gravity of Various Rotary Counterbalances of Approximately the Same Dead Weight.

Make of C. B.	Center of Gravity in Inches	Radius of Crank for 4th Hole A. P. I.	Dead Weight	Effective Weight
A	26.9"	27"	4,600	4,580
B	37.5"	27"	4,863	6,759
C	51.4"	27"	4,750	9,050
D	39.7"	27"	4,627	6,800

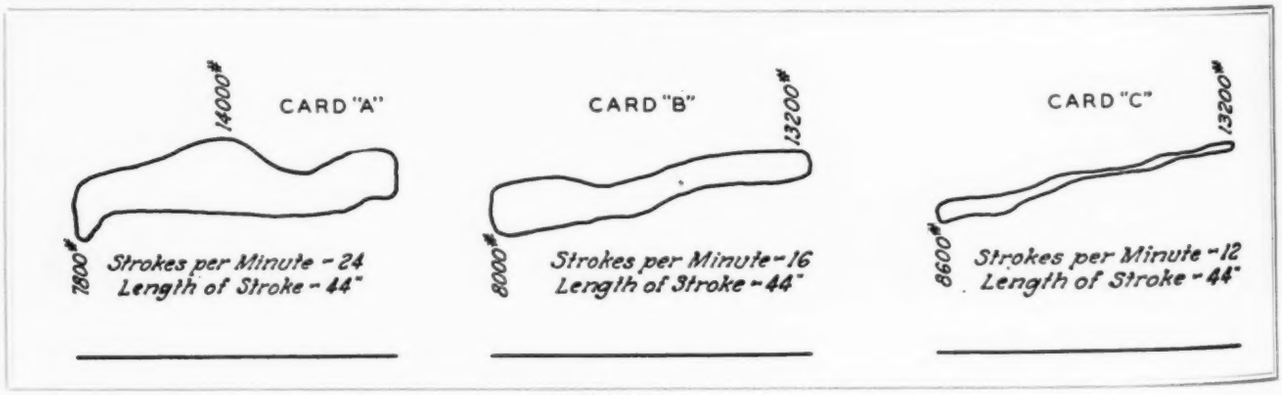
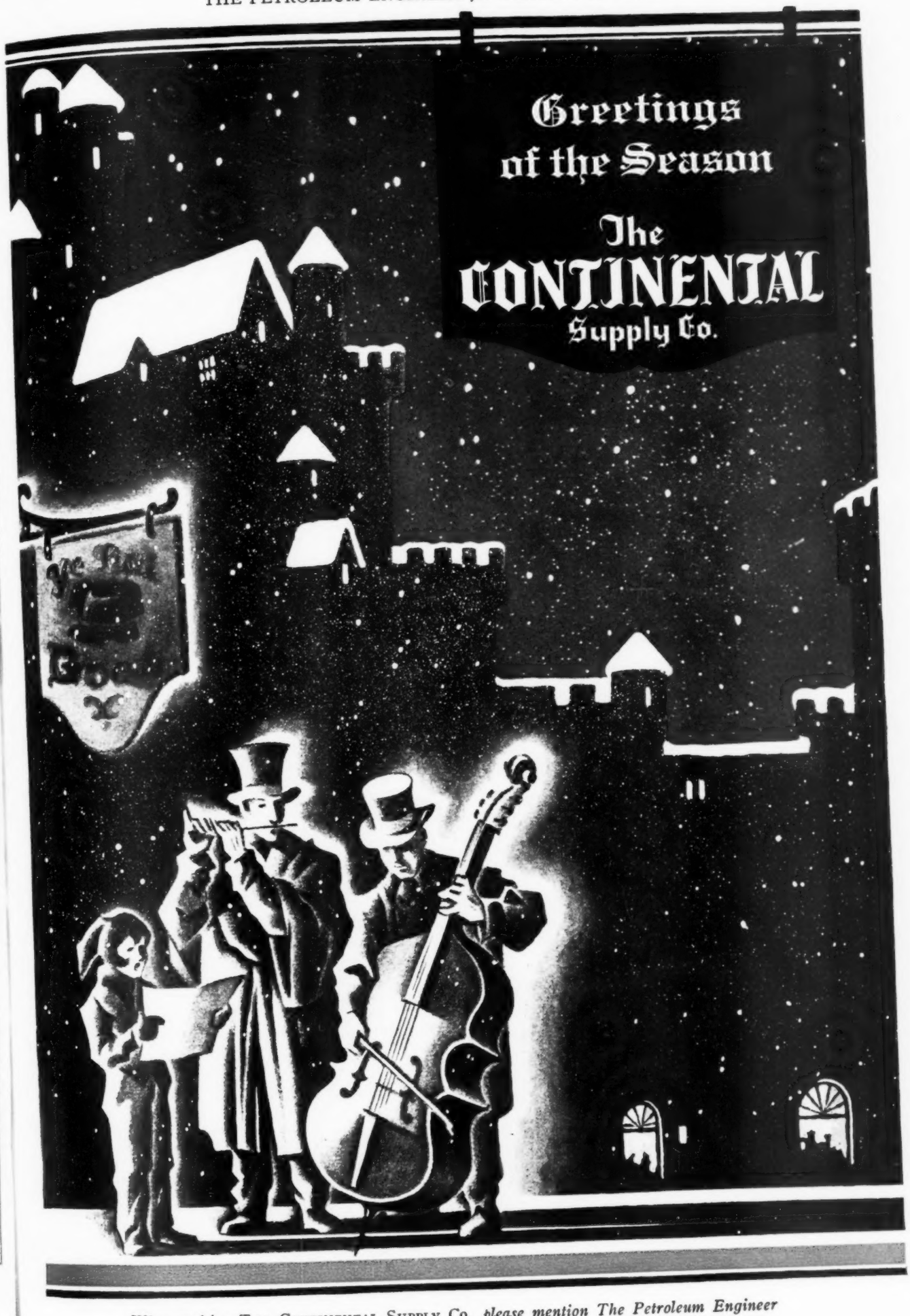


FIGURE No. 4



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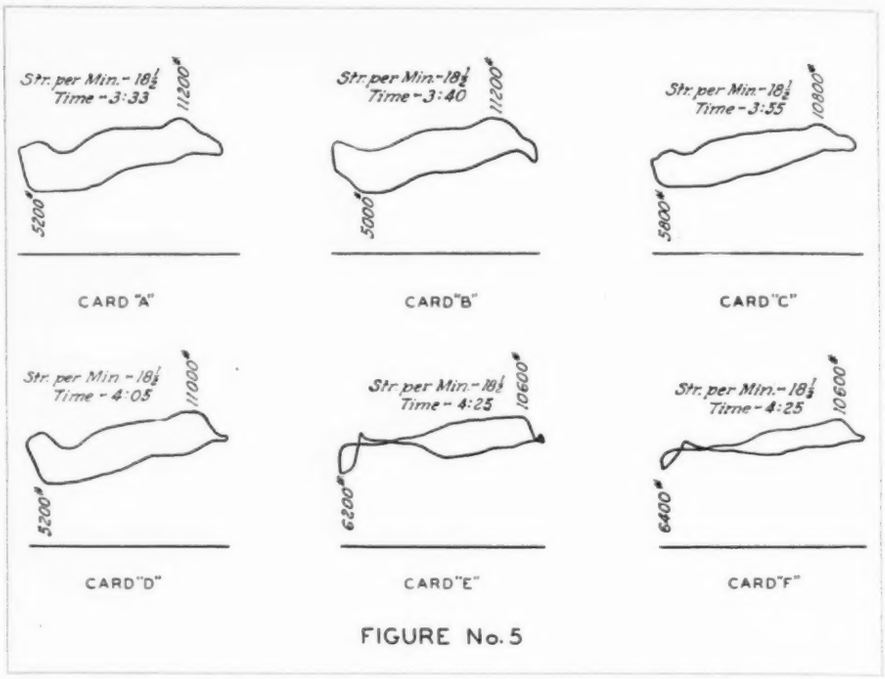

FIGURE No. 5

It can readily be seen that there is a wide variation in the effective weight secured from various counterbalances. Similarly, there is a wide difference in centers of gravity for these balances with approximately the same dead weight. As dead weight is paid for in the purchase of a counterbalance, it is obvious that the balance giving the greatest effective weight in proportion to its dead weight, is the most economical. A big asset that must be considered is the ease with which a counterbalance can be removed for well pulling, also the ease with which weights can be added to or removed from the counterbalance. For all ranges of service the rotary type counterbalance has come into general use. At slow uniform speeds the grasshopper type of counterbalance is very useful, but at the higher speeds, especially when under-counterbalanced, this type of counterbalance has too much inertia, the effect of which can be observed in the pony beam supporting the weights, or there is too much spring in the lever supporting the weights.

In figuring the counterbalance weight necessary to counterbalance a well correctly, the author has found that the method of figuring torque for the well load, then the counterbalance, and comparing the resultant of both of these throughout the up and down stroke, is sufficiently accurate. Actual experience has shown that this method is not far from being correct. Figure 6 shows the result on one well where this method was used. The performance of the well after counterbalancing is evidence that the method yields excellent results and is sound.

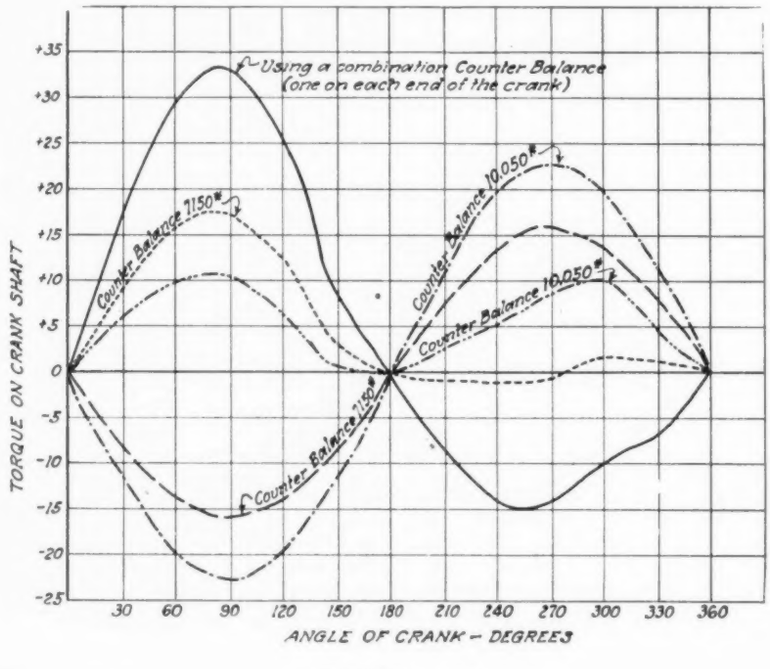

FIGURE No. 6

A method of checking counterbalancing by use of a stop-watch has been tried. This method is based on the assumption that a well is correctly counterbalanced if the time from the top of the stroke to the bottom does not vary 1/5 of a second from the time of the stroke from the bottom to the top. This method has worked out satisfactorily on wells operated by electric motors, but does not check out on gas-engine powered wells. Apparently, the reason for this is that the gas engine fires during a cycle of the pumping stroke regardless of the position of the crank or the load. Also, it may fire at different angles of the crank during several revolutions of the crank.

Summary.

By intelligent application of dynamometer data, a great deal of good work can be accomplished in analyzing pumping troubles in a well and in suggesting means to correct same. Knowledge of the particular wells and their peculiarities, combined with the information furnished by dynamometer readings, provides a short cut that yields definite and successful results. With the introduction of the dynamometer for weighing wells, has come a more thorough understanding and appreciation of pumping problems, and vast progress in this branch of oil producing operations should be made within the next few years. The combination of the practical man's knowledge with that derived from instruments such as the dynamometer should point to the solution of the most difficult pumping problem.

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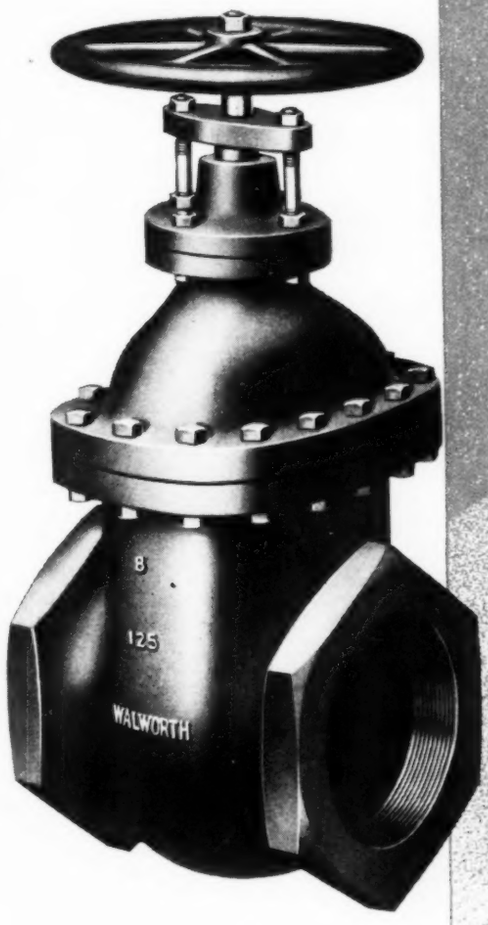
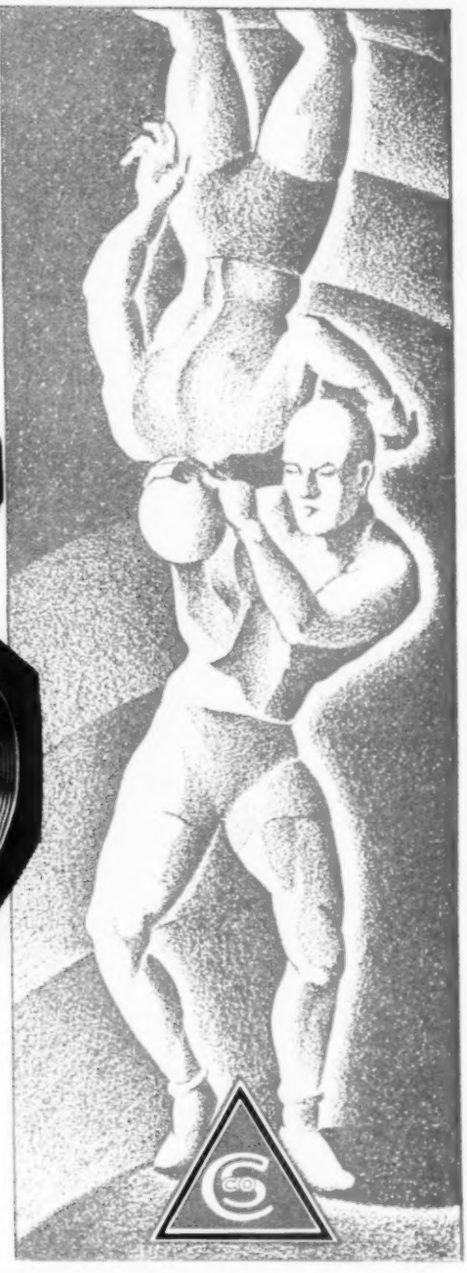


Within its recommended pressure range, the WALWORTH valve will stand lots of rough usage. Its rugged construction and mechanically perfect design make it the right valve where greater strength is needed.



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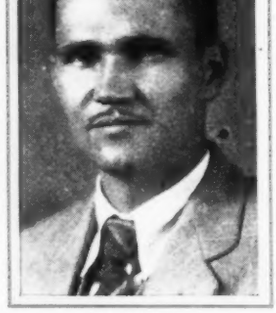
Load Dispatching

An Important Factor in Natural Gas Transportation

By R. H. JOHNSTON, *Chief Dispatcher, Arkansas-Louisiana Pipe Line Co.*



R. H. Johnston

COMPARATIVELY few people not directly connected with the natural gas industry have anything like a definite conception of how the "Gas Company" maintains an adequate supply of gas in the lines for their consumption, nor do they realize the magnitude of this task. Regardless of weather conditions the public expects and demands an abundance of this perfect fuel so vital to their comfort. The responsibility of maintaining this supply rests upon the load dispatcher.

There are numerous factors to be considered in determining the load a pipe line is capable of carrying and the proper load it should carry each day. A few of the most important considerations are as follows: Volume and pressure of field supply, compressor and line capacities, size and length of line, maximum allowable pressure with reasonable safety factor, prevailing weather conditions and probable demand. It is essential that the dispatcher should have a thorough working knowledge of the entire pipe line system. It is with the method of comprehensively organizing all these factors for the purpose of efficient load dispatching that this article proposes to deal.

In order to make possible a clear conception of the pipeline system as a unit, a large, detailed, schematic diagram similar to Fig. 1 should be made of the entire system. This diagram should be divided into districts; a district being comprised of the line between each major delivery or receiving point, or between each main line check meter.

From this diagram, line capacity charts may be plotted of each district and of each main line system, Fig. 2. Each town border station or delivery point usually has a specific contract pressure which under the terms of the agreement between the transporting company and the distributing company must be maintained. Using this delivery pressure as a basis and allowing a reasonable excess pressure as a desir-

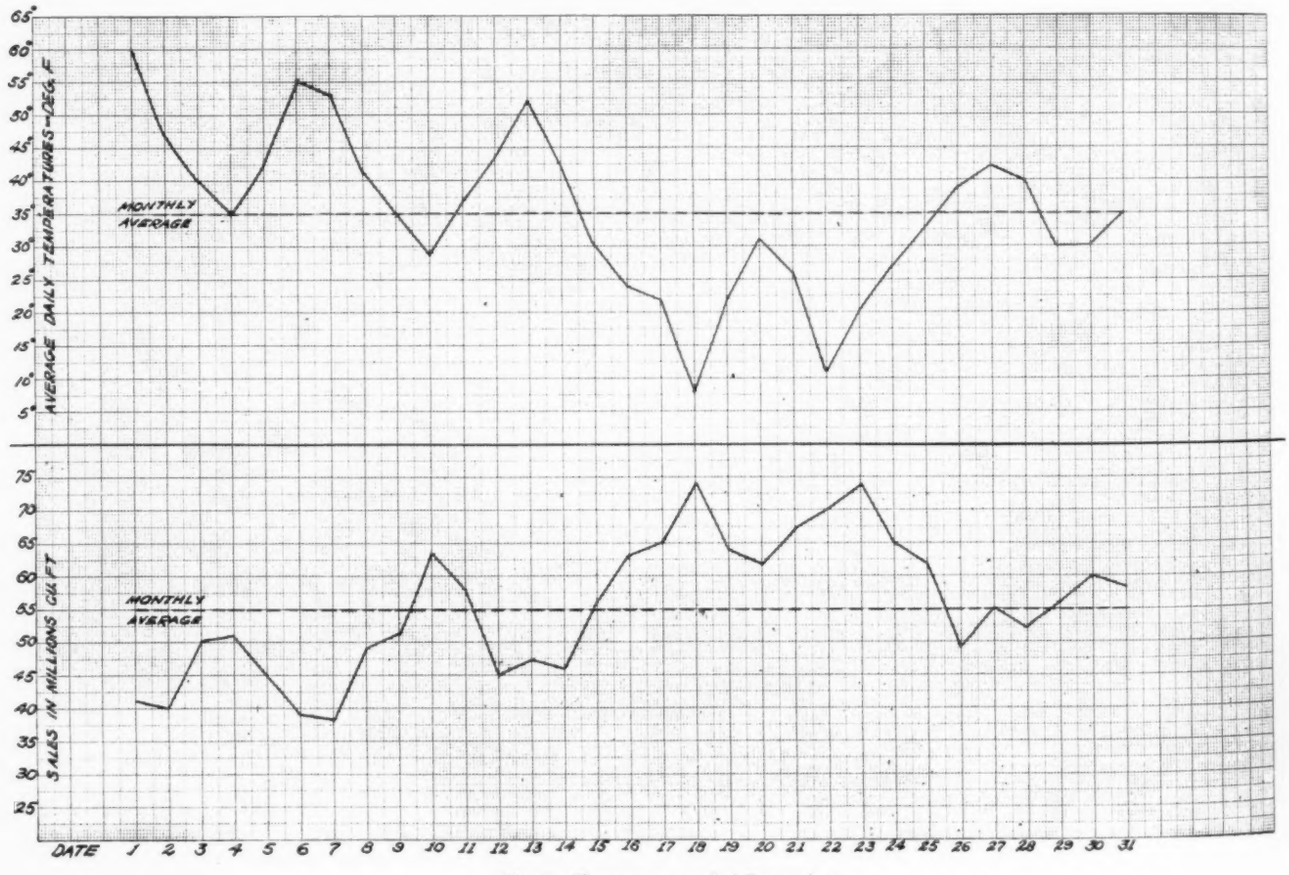

AVERAGE DAILY TEMPERATURES—DEG. F
MONTHLY AVERAGE
SALES IN MILLIONS CU FT
MONTHLY AVERAGE
DATE
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

Fig. 3—Temperature and delivery chart.

THE

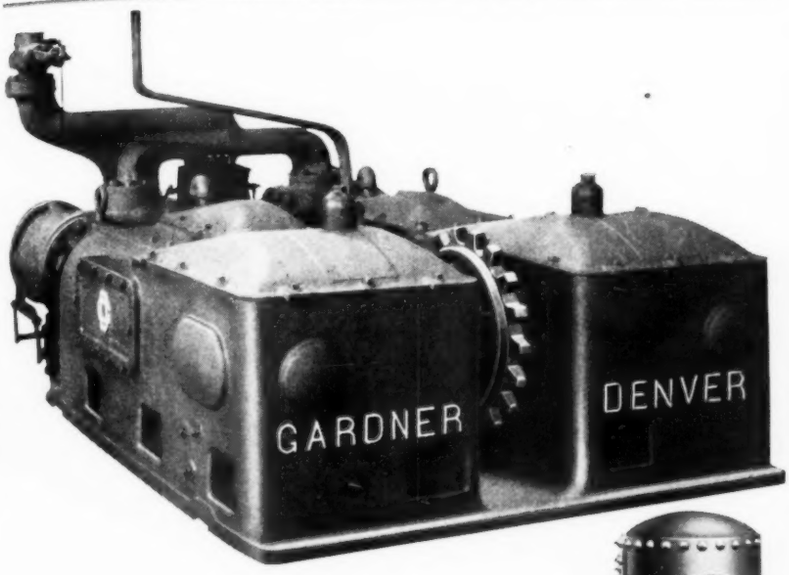
GARDNER-DENVER

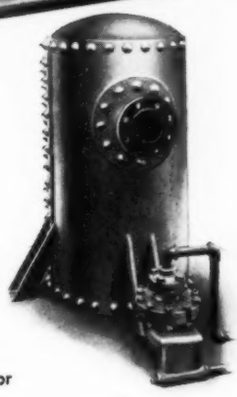
PISTON VALVE

12 X 12

TWIN DRILLING ENGINE

WITH SUPERHEATED STEAM....





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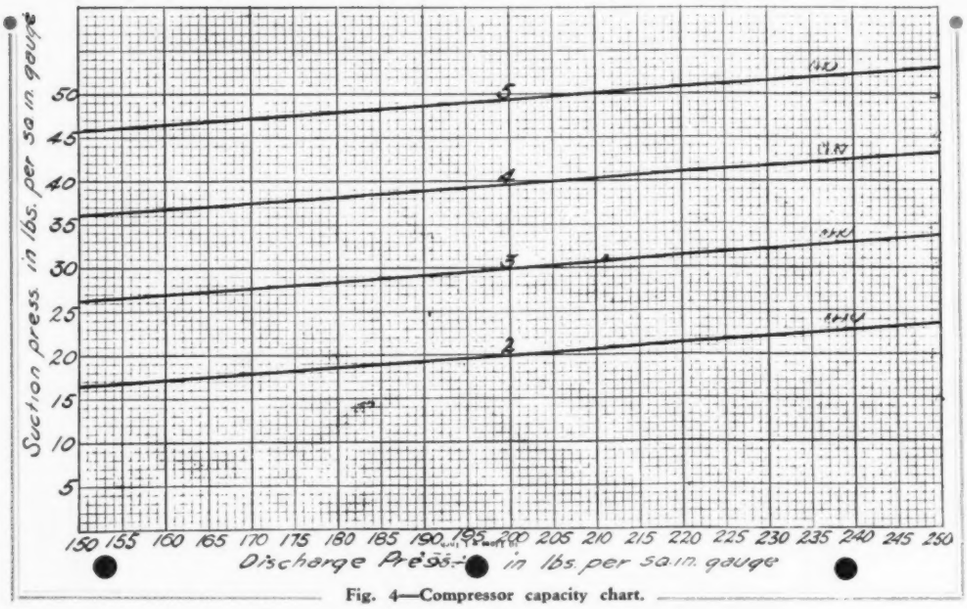


Fig. 4—Compressor capacity chart.

able operating pressure, the required initial pressures necessary for certain loads may be determined and plotted on the line capacity charts.

Example:

District 11—25 miles of 12-inch line, required town border pressure—125 pounds per square inch gauge. Suitable operating pressure—150 pounds per square inch gauge.

Using Oliphant's formula for pipe line capacities:

$$Q = 1008\ a \sqrt{\frac{P_1^2 - P_2^2}{L}} \times^{*} \sqrt{\frac{.6}{G}} \times^{*} K, \text{ in which}$$

Q = Twenty-four-hour delivery in cubic feet,
a = Constant governed by diameter of pipe,
(See list of values of "a" for various pipe diameters listed below)
P_1 = Initial pressure in lbs. per sq. in., absolute,
P_2 = Delivery pressure in lbs. per sq. in., absolute,
G = Flowing specific gravity of gas,
K = Temperature correction factor,
L = Length of line in miles.

Table for Values of "a"

Pipe Size	Value	Pipe Size	Value
1-inch	1.000	8-inch	198.000
2-inch	5.920	10-inch	350.000
3-inch	16.500	12-inch	556.000
4-inch	34.100	13½-inch	725.000
5-inch	60.000	16-inch	1160.000
6-inch	95.000	18-inch	1570.000

In our problem we will assume that,

Q = 10,000,000 cubic feet

Substituting,

$$10{,}000{,}000 = 1008 \times 556 \times \sqrt{\frac{P_1^2 - (164.65)^2}{25}}$$

$1008 \times 556 = 560{,}448$ then the factor

$$\sqrt{\frac{P_1^2 - (164.65)^2}{25}} = \frac{10{,}000{,}000}{560{,}448} = 17.842$$

$$(17.842)^2 = 318$$

$$318 = \frac{P_1^2 - 35{,}967}{25}$$

$$P_1^2 = 43{,}917$$

P_1 = 209.58 pounds per square inch, absolute, or 195 pounds per square inch, gauge, which is the required initial pressure.

These charts are not intended to be a positive guide as to the pressure to put on a line when there is a cold wave materializing. They prove very helpful, however, in the regulation of initial pressures under constant load conditions which very frequently occur, especially in industrial centers where the domestic load is correspondingly small as compared to the total load. The local pressure man can set his control or regulator on instructions from the load dispatcher on the correct pressure with a single operation, thus saving the necessity of tediously experimenting until the proper pressure is obtained.

There is always a "process lag" involved in the boosting of pressure at the delivery point, depending on the velocity of the gas and the size and length of the line. This lag can be accurately gauged only by experience. The manner in which the "process lag" may be minimized after the anticipated load has been tentatively decided upon is by increasing the input considerably more than enough to offset the increased demand plus the line "pack." "Pack" is a term applied to gas absorbed by the pipe line in raising the pressure; or gas stored in the line. The amount of "pack" necessary in increasing a line delivery is arrived at by computing the amount of gas which the line holds at the prevailing average pressure and the amount it will hold at the average pressure which will be in the line after the load has been increased; the difference between these two amounts is the amount of "pack" or gas that the line will absorb before the market end is materially benefited by the increased input of gas. It is good practice in making a large increase on a long line of large diameter to increase the input to about 150 per cent of the expected load plus the "pack," and hold it that way until the actual load becomes apparent and the velocity increase overcomes the "process lag," then decrease to input to equal the load at the delivery point. The presence of an excessive amount of gas in the line is liable to result from following this procedure in case the demand does not materialize as anticipated. This condition is much more desirable than having an insufficient supply on hand despite the difficulty encountered in lowering the line pressure, as postponed sales of gas are never made up, they represent money lost.

A very helpful means by which a load may be anticipated is by charting a comparative analysis of actual daily deliveries against the average daily temperatures, by districts and for the system as a whole, Fig. 3. The weather forecast can be compared to this chart and the day on the chart which embodies temperatures similar to the forecasted temperatures can be used as a fairly accurate guide upon which the anticipated load may be computed, provided of course that market growth, if any, between the time of compilation of the chart and current time, is given due consideration.

In transporting gas from fields that do not have sufficient "rock" or natural pressure to force the gas through pipe lines to its destination "booster" or compressor stations are installed for the purpose of increasing the pressure to such

* Negligible in rough calculations.

LIGHT WEIGHT Naylor Pipe

Withstands High Pressures

20-inch Naylor Pipe in Testing Machine during Internal Hydrostatic Pressure Tests

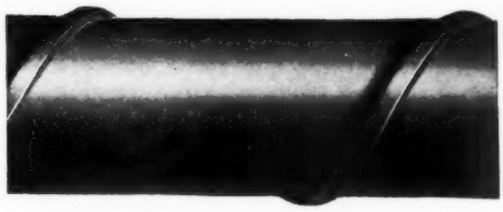
No.2—Internal Hydrostatic Pressure Tests.

Every length of Naylor Pipe is tested to the pressures indicated in the following table:

Diameter of Pipe	Mill Test Lbs. per Sq. In.	Diameter of Pipe	Mill Test Lbs. per Sq. In.
6″	900	14″ O. D.	450
8″	800	16″ O. D.	400
10″	700	18″ O. D.	350
12″	500	20″ O. D.	325

Extensive tests recently made by Professor M. L. Enger and W. M. Lansford of the Materials Testing Laboratory of the University of Illinois, bear out the soundness of this practice.

In the course of these tests it was shown that the bursting strength of Naylor Pipe computed in accordance with the formula $p = \frac{2ts}{d}$ was less than the bursting strength found by experiment. This means that the Naylor Structure is definitely responsible for an increase in resistance to internal hydrostatic pressure.



Catalog 30-2 gives you complete engineering and metallurgical data.

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Naylor Pipe

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Standardized Naylor Pipe is made in sizes 6″ to 12″ I. D. and 14″ to 20″ O. D. in any uniform length desired up to 40'0″. Ends made to wrought pipe standards for all types of coupling.

Toncan Copper Molybdenum Iron possesses a superior corrosion resistance, making it the favored pipe material.

Where corrosion is not a problem, Naylor Pipe can be furnished in steel.

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an extent that the required amount of pressure may be held at the delivery end of the line. The load dispatcher has jurisdiction over these stations as to the number of compressors they shall operate.

After the input from the wells on the suction side of a compressor station has been increased or decreased, the problem of how many compressors to put on or take off the line and at what speed they shall operate to hold a steady suction pressure on which the compressors will operate efficiently arises. Compressor units are usually of such large capacity that one unit more or less on the line will make a great difference in the amount of gas handled.

For the purpose of determining the number of compressors to put on the line and at what speed they should run to handle a specific amount of gas the dispatcher should have capacity charts at hand for each type and size compressor on the system, Fig. 4. These curves are calculated from the formula:

$$C = \frac{P}{p} \times Q, \text{ in which}$$

C = Capacity of compressor

$Q = S \times D\ [1 + C - C\ (R)^{\frac{1}{n}}]$

Q = Actual quantity of gas compressed per revolution,

S = Speed of engine,

D = Displacement of piston, rod, etc., in cu. ft. per revolution,

C = Per cent clearance,

R = Ratio of compression $\frac{\text{(Discharge, absolute)}}{\text{Suction, absolute}}$

n = 1.265

P = Suction pressure, lbs. per sq. in. absolute,

p = Atmospheric pressure or base pressure.

Often a pipe line gets in such a state of disrepair that it becomes necessary to shut down and drain a section of the line for four or five hours to make the necessary repairs. The dispatcher is notified of all such cases, and if there is sufficient line storage space between the point of repairs and the delivery point, the line pressure can be built up until a sufficient amount of gas is in the line to carry the sales while repairs are being made, due discretion being used as to how high the pressure is raised. A line should never be subjected to more than 70 per cent of the hydrostatic mill test of the pipe.

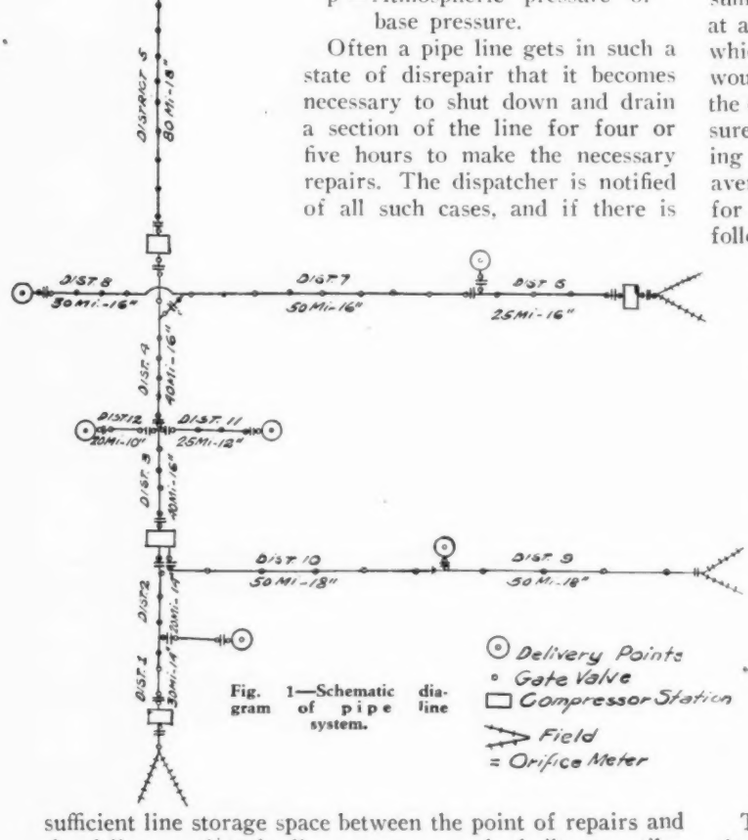

Fig. 1—Schematic diagram of pipe line system.

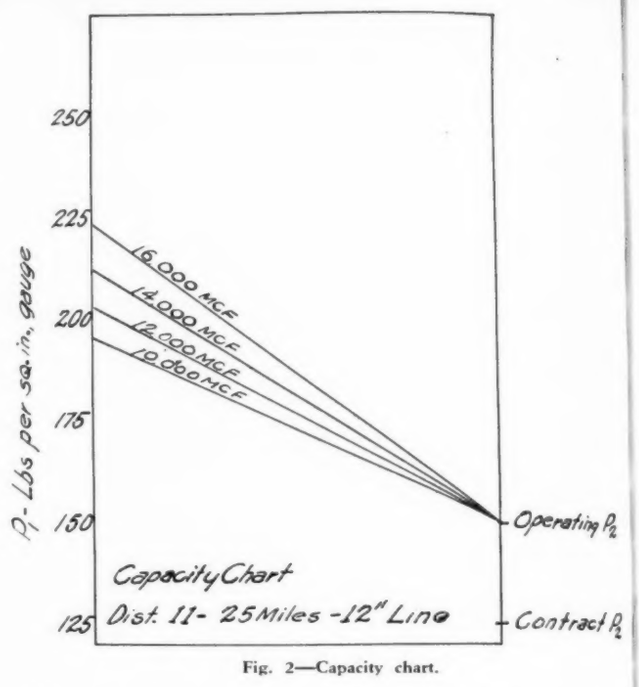

Fig. 2—Capacity chart.

Suppose an 18-inch line has to be cut and repaired 75 miles distant from a major delivery point and the length of time necessary for making repairs is four hours. The best plan to follow is to get in touch with all the industrial consumers along the section of line to be bottled up and get an estimate of the amount of gas per hour that they will consume. Assuming this amount to be 750 MCF per hour at a base pressure of 14.65 pounds per square inch absolute which would be 3,000 MCF for four hours, the objective would be to "pack" at least 3,000 MCF into the line above the capacity of the line at the lowest desirable working pressure. Further assuming the lowest desirable average working pressure to be 100 pounds per square inch gauge, the average pressure which will be necessary to put on the line for it to hold the additional 3,000 MCF can be found as follows:

The volumetric capacity of 1 foot of 18-inch O. D. pipe is approximately 1.6101 cubic feet, therefore

75 miles (396,000 feet) of 18-inch O. D. pipe will have a volumetric capacity of 637,600 cubic feet.

The capacity of this section at 100 pounds per square inch gauge (114.65 pounds absolute) average converted to base pressure is

$$637{,}600 \times \frac{114.65}{14.65} = 4{,}989{,}794 \text{ cubic feet.}$$

Desired volume = 4,989,794 + 3,000,000 = 7,989,794 cubic feet.

As the amount of gas (weight) is directly proportional to the pressure the desired average pressure is found by the equation:

$7.8259 : 4{,}989{,}794 :: X : 7{,}989{,}794$

X = 12.531 which is the ratio of the desired average pressure to the base pressure.

$12.531 \times 14.65 = 183.58$ pounds per square inch absolute or 174 pounds per square inch gauge = Desired average pressure to put in the line to carry load while shut down is in effect.

Telephone and telegraph communication facilities between the main office and all important points on the pipe line system, such as main line check meters, compressor stations, fields and delivery points represent an indispensable item in the equipment necessary to efficient load dispatching.

A Study of Drilling Speeds Used in Russia

By P. GOLIAKOV[1]

THE question of the speed of drilling has, so far, been greatly neglected, but very few articles covering the problem being published. Only in the last few months has the study attracted the attention of several departments and also of individual engineers. More particularly has drilling speed been studied in the Grozny oil fields.

The problems connected with drilling speed and its major factors are of importance to the oil industry, and a correct interpretation of these factors cannot but help increase the efficiency of drilling operations.

The factors governing drilling speed are closely related to the factors affecting the cutting of metals. Thus the speed of actual drilling depends upon: (a) the cutting speed—the number of strokes by the walking-beam in cable tool drilling, and the number of revolutions of the rotary table in rotary drilling, per unit of time; (b) rate of feed—in cable tool drilling the rate of feed is the average amount of hole made or shattered by one stroke of the walking-beam under a certain average penetration of the bit into the formation, for rotary drilling the rate of feed is the average penetration per one rotation of the bit. Especially difficult is the problem of rate of feed, which is dependent on several very complicated factors, particularly in cable tool drilling, where no automatic feed has been perfected, and the removal of cuttings from the hole is periodical.

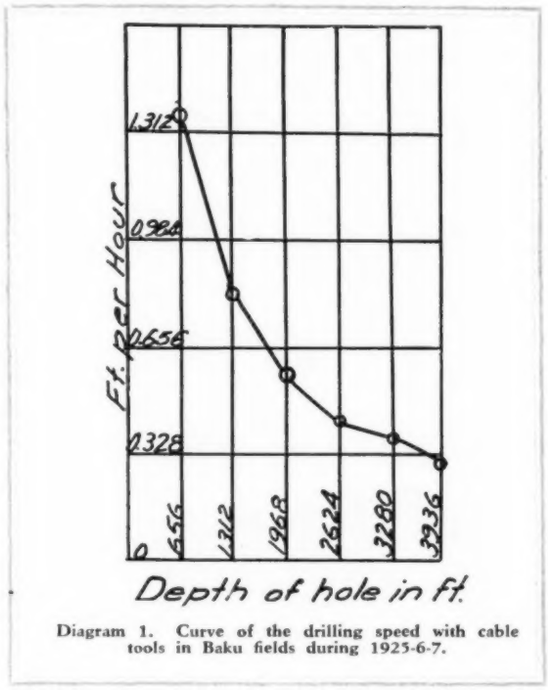

Diagram 1. Curve of the drilling speed with cable tools in Baku fields during 1925-6-7.

All factors affecting the speed of cutting can be divided in the following four groups:

(1) Rig equipment;
(2) Tools;
(3) Well conditions;
(4) Labor, organization, etc.

Some of these factors are, of course, interdependent. For example, the rate of speed of the rotary table is dependent both on the rig equipment and on the ability of the driller. The following table enumerates the factors governing the speed of drilling as divided in the above four groups:

I

Factors of Rig Equipment

(In Rotary Drilling.)

(1) Revolutions per minute of the rotary table;
(2) Strokes per minute, and the pressure of the mud pumps;
(3) Type of engine, whether steam, electrical, gas or oil;
(4) Availability of automatic feed control apparatus.

(In Cable Tool Drilling.)

(1) Strokes per minute of the walking-beam;
(2) Length of stroke of the walking-beam;

[1]Translation of an article from an issue of AZERBEIDJAN PETROLEUM INDUSTRY, published in Baku, U. S. S. R.

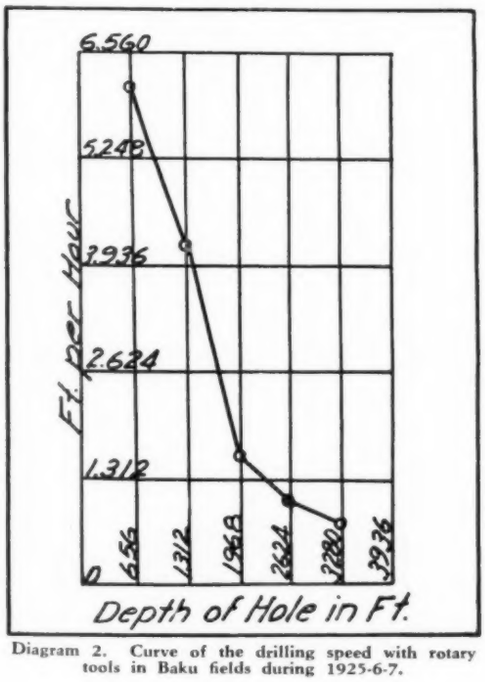

Diagram 2. Curve of the drilling speed with rotary tools in Baku fields during 1925-6-7.

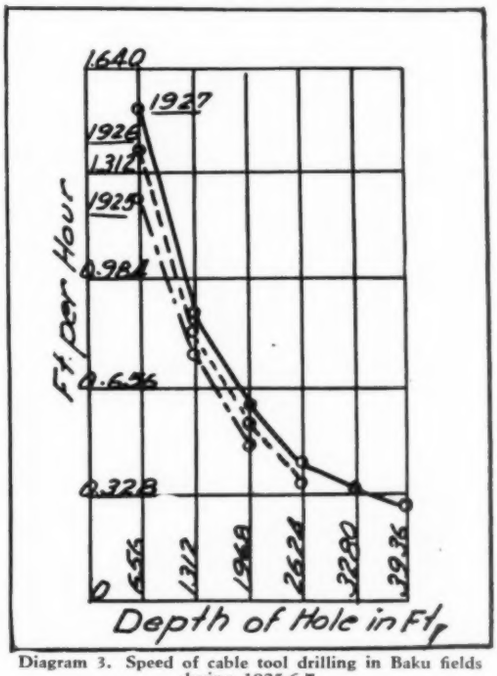

Diagram 3. Speed of cable tool drilling in Baku fields during 1925-6-7.

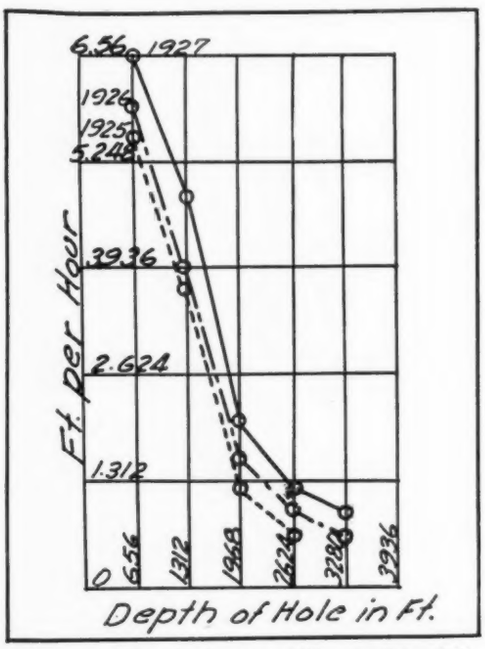

Diagram 4. Speed of rotary drilling in Baku fields during 1925-6-7.

(3) Type of engine, whether steam, electrical, gas or oil.

II

Factors of Tools

(In Rotary Drilling.)

(1) Chemical composition of the steel forming the cutting edges of the bit;

(2) Heat treatment of the bit, or its facing;

(3) Type and shape of bits;

(4) Angles of cutting edges and angles of cutting the formations;

(5) Weight and pressure of the bit.

(In Cable Tool Drilling.)

(1) Chemical composition of the steel forming the cutting edges of the bit;

(2) Heat treatment of the bit, or its facing;

(3) Type and shape of bits;

(4) Angles of cutting edge, or edges, of bit;

(5) Weight of drilling tools;

(6) The diameter and quality of the drilling cable; influence of periodical increase in length of the cable while drilling;

(7) Number of turns of the bit in relation to the number of strokes of the walking-beam;

(8) Shape and diameter of underreamers, drilling jars and other tools.

III

Factors of Well Conditions

(In Rotary and Cable Tool Drilling.)

(1) Depth of drilling;

(2) Type of geological formations, angle of dip, and thickness of formations;

(3) Diameter of the bit;

(4) Diameter of the underreamer;

(5) Density of the mud, in rotary drilling.

IV.

Factors of Labor, Organization, etc.

(In Rotary and Cable Tool Drilling.)

(1) Efficiency and quality of labor;

(2) Efficiency and preparedness of organization;

(3) Presence of bonus payments for labor;

(4) Season of year;

(5) Time of day or night.

From the above classification, which is itself far from being exhaustive, it can be observed that the speed of actual drilling is dependent upon a large number of variable factors. Therefore the calculations and determinations of the speed of drilling, without considering even only the major affecting factors, cannot furnish a correct interpretation of

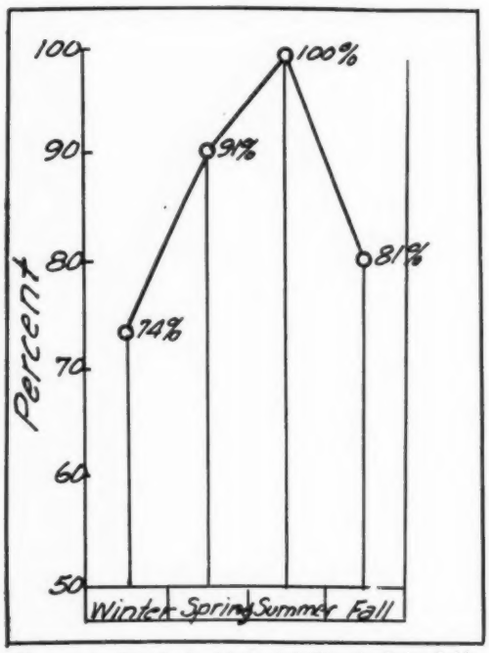

Diagram 5. Speed of cable tool drilling in Baku fields as influenced by seasons of the year.

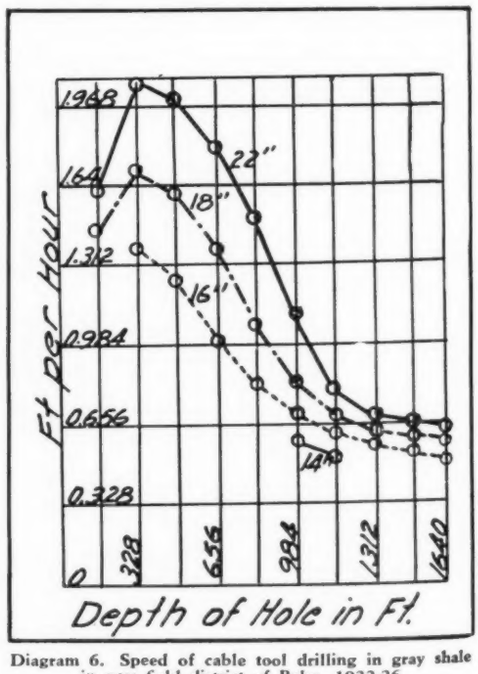

Diagram 6. Speed of cable tool drilling in gray shale in new field district of Baku, 1922-26.

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the real efficiency of drilling. So far, the speed of drilling has been considered only from the depth factor, and all other factors overlooked. Data so figured may be considered as sufficient for determining the average "total" speed of drilling, but for more serious analysis some of the other factors must be taken into account.

Statistical Methods of Studying the Factors of Drilling Speed

The greater the number of factors affecting some special type of work, the more complicated becomes the study of individual factors. In most cases, however, it is possible to choose a particular factor, equalizing all other factors as much as conditions permit. Thus in rotary drilling, to determine the drilling speed as influenced by the number of revolutions of the bit, it is necessary to accumulate data on the speed of drilling under various revolutions per minute, but with other factors being similar, that is, depth, formation, type of tools, etc. The correctness of the study of some one factor depends entirely on the possibility of equalizing all other factors, while altering the work of the factor being studied.

The order of study of various factors must begin with simpler methods and gradually include more complicated special experiments and observations. The following steps should be taken: (a) preliminary study of the experiences of individuals; (b) collection of statistical data from well logs; (c) collection of timed data under existing drilling conditions; (d) collection of timed data under experimental drilling conditions, varied as indicated by special investigators; (e) special experiments, including laboratory work.

Beginning with the collection of statistical data and analyzing the figures thus obtained, the following governing factors were carefully studied: (a) geological formations, (b) depth of well, (c) season of year, as well as separate years, and (d) diameters of holes.

The basic sources of material for study were the well logs, and accordingly, it becomes important to consider the correctness of such a source. It is known that notations in log books do not furnish data as exact as that obtained by special timing inspectors. The discrepancies concern primarily the distribution of time, because the entries are not made oftener than once in twelve minutes to once in an hour, the latter figure being more nearly correct, this being a rather large unit of time for careful analysis. But as the number of source material increases, the correctness of the combined data increases accordingly. To confirm the above statement, Table No. 1 shows the data of well No. 29-23 in the New Field District of Baku for several days, both from the well log book and from the special timing observations during the same period of time.

From Table No. 1 it can be observed that while the well log data of individual days show considerable discrepancies

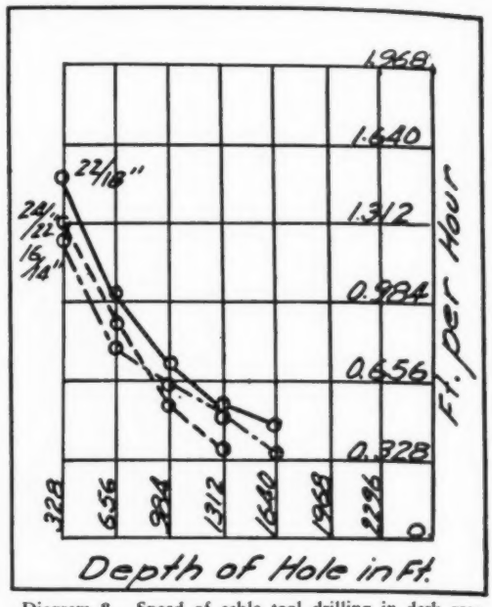

Diagram 8. Speed of cable tool drilling in dark gray shales in both districts of Baku fields, 1925-6-7.

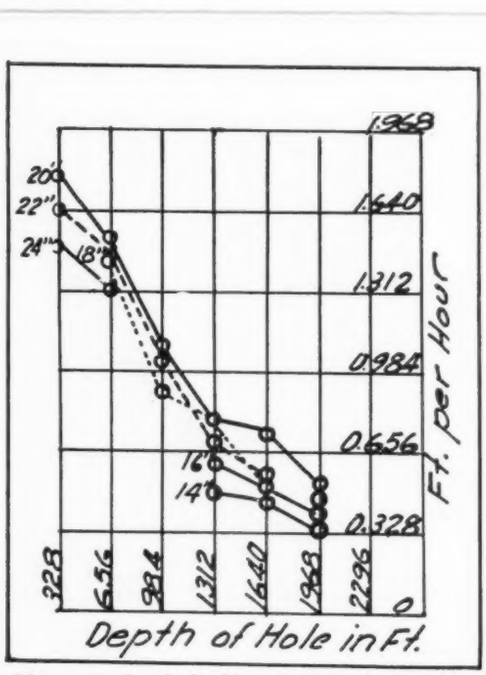

Diagram 7. Speed of cable tool drilling in gray shales in new field district of Baku fields, 1925-6-7.

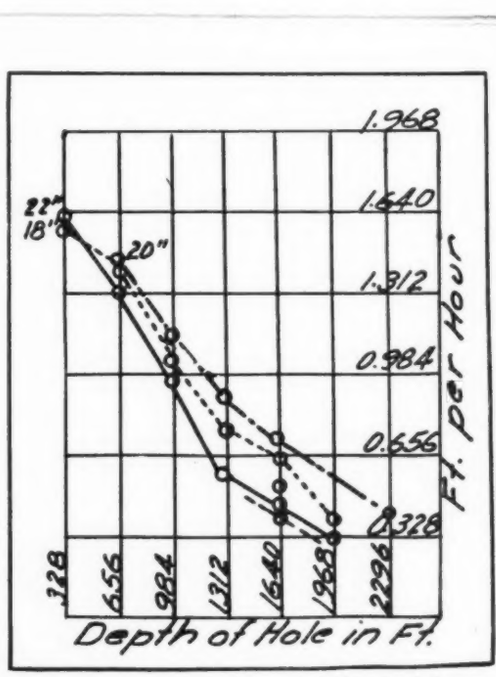

Diagram 9. Speed of cable tool drilling in dark gray shales in new field district of Baku fields, 1925-26-27.

as compared with the timed observations for the longer periods of time the discrepancies are reduced to but a negligible amount.

To make the statistical data available through the well log books more satisfactory for determining the actual speed of drilling, the following entered factors were eliminated from the calculations: (a) preliminary and final stages of drilling, such as rigging up, bailing, and swabbing to test for production, etc., (b) secondary items, such as splicing of the line, repairs to belting equipment, sampling, change of tools, etc., (c) special items, such as cementing, running of casing, etc., (d) loss of time due to fishing, general repairs, absence of energy, absence of materials, etc., or lack of labor. After the exclusion of all the above items, the well log books would show in rotary drilling the actual drilling time, and in cable tool drilling actual drilling time, lowering and lifting of the tools, and also cleaning of the hole. In addition, a number of minor losses of time not recorded in log books were omitted. The above method of excluding all processes not directly related to drilling, thus also not affecting the results by losses of time due to factors unrelated to drilling, furnishes sufficiently exact results for the analysis of drilling speeds.

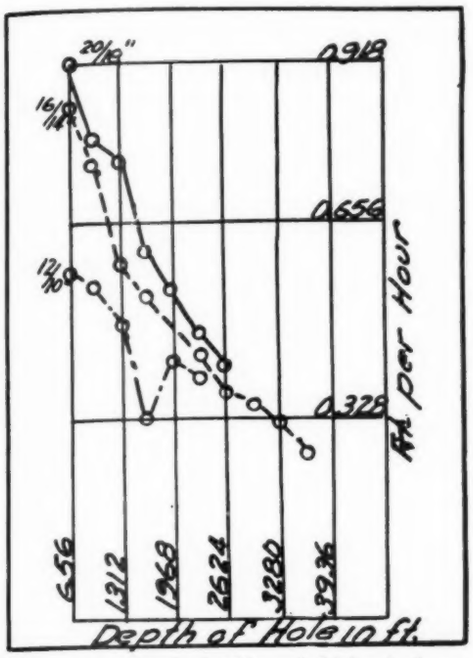

Diagram 10. Speed of cable tool drilling in brown shales with sandy breaks in both districts of Baku fields, 1925-26-27.

Obtaining such statistical data, less the foregoing indicated exceptions, the speed of drilling has been calculated as shown: (a) by depth intervals of 164 feet (equal to 50 meters); (b) by various geological formations; (c) by seasons of the year, and by separate years; (d) by the diameters of the holes.

In practice the following procedure was adopted. For each interval of depth the time of drilling was determined (less the secondary items), it then being figured under the heads of geological formations, diameter of hole, seasons of the year and the separate years, then the average speed of drilling was calculated per each depth interval as dependent on the foregoing indicated separate factors. This method of working out the log book information is not entirely satisfactory, primarily because a number of factors, such as revolutions per minute, efficiency of labor, and others, must necessarily be overlooked. But in the case where a large amount of information is being worked out, all factors are more or less equalized and do not affect the final results of the analysis.

In starting this work sixty-eight cable tool well log books were analyzed, as already indicated, during the year 1927, the wells concerned being drilled during 1922-1926 period in the New Field District of Baku, with total footage equal to 92,300 feet, and twenty-nine cable tool log books in the Old Field District, with total footage equal to 53,200 feet, or a combined total of ninety-seven wells with total footage of 145,500 feet.

Somewhat unexpected results made it necessary to make an additional study during 1928-1929 to make the results obtained more reliable, at the same time including the rotary drilling in the analysis. The number of well log books statistically analyzed is shown in Table 2. The total footage of cable tool wells was 322,200 feet, and of rotary, 186,800 feet, or a combined total of 510,000 feet. This amount of data can be considered as entirely sufficient for detailed analysis of the factors governing drilling speed.

(The concluding article of this series will appear in the January, 1931, issue.—Ed.)

TABLE No. 1

Date	Feet Per Day		Hours Working		Hours Shut Down	
	Well Log Book	Timed	Well Log Book	Timed	Well Log Book	Timed
Sept.						
15	21	25	12	22.2	12	1.8
16	28	34	18	18.3	6	5.7
17	49	41	24	22.7	....	1.3
Oct.						
13	11	24	16	17.6	8	6.4
14	15	23	20	18.1	4	5.9
15	14	15	16	11.5	8	12.5
23 Days Total	616	617	417	422.9	135	129.1
Average Per Day ..	26.8	26.8	18.1	18.3	5.9	5.7

TABLE No. 2

Method of Drilling	Years	Old Field District	New Field District	Total
Cable Tools	1925	38	30	68
	1926	52	12	64
	1927	44	10	54
	Total	134	52	186
Rotary	1925	3	11	14
	1926	4	15	19
	1927	15	28	43
	Total	22	54	76
Combined Totals		156	106	262

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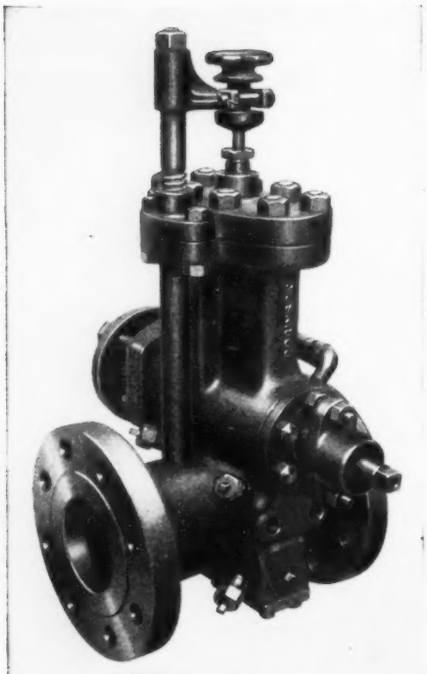

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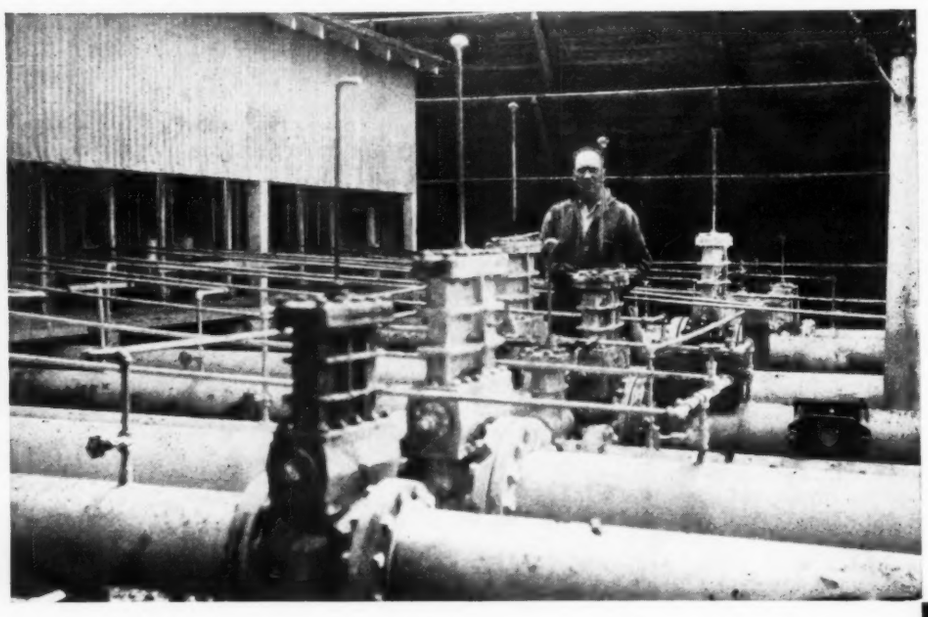

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Some Aspects *of* Grease Lubrication

Effect of Composition and Properties Upon Lubrication

By H. R. MATHAS, *Lubrication Engineer.*

GREASE lubrication depends for its success chiefly upon skillful choice of product and proper method of application. although to be sure, inbuilt quality of the lubricant itself is of the utmost importance.

Many lubricating engineers and others called upon to deal with a problem manifestly requiring grease for the most satisfactory service feel at a loss as to which product to choose and how to apply it. This condition is due in part to the mystery which has been spread over the subject in the past, in part to the misinformation extant on the subject with the inevitable results of confusion and suspicion, and in part to practically complete absence of any authoritative source of information on the subject understandable or useful to those not primarily interested from a technical standpoint. It is true that considerable information is continually being published on the art and science of grease-making, but contributions to the literature on the use and application of grease products are scattered and for the most part lacking in sufficient detail.

Grease kettle used for saponifying base for grease under pressure.

It is the purpose of this series to clear up some of the mystery in which grease is befogged as far as non-technical users are concerned and to correct as far as possible items of misinformation which are met on every side. It is hoped that during this process enough information will be given to fill a small corner of the vast void existing. Finally, for some thorough technical man with wide practical experience, gifted with the ability of making hard things seem easy, and impressed with the inadequacy of this series, is prevailed upon to prepare a compendium on the subject, we feel that such a contribution would be gratefully accepted.

It is evident that the purpose of lubrication is the minimizing of friction and reduction of rate of wear. The best lubricant for a certain condition is one which accomplishes as perfectly as possible both these ideals. The choice of this optimum lubricant is made after consideration of such items as pressure, speed, temperature, method of lubrication, design of parts, kind of rubbing surfaces, and special operating conditions. Oil should be used wherever possible because friction is generally less than with grease and likewise initial cost. However, for certain conditions, greases are superior to oils and, hence, supply an actual lubricating need.

A true grease is usually defined as a solid or semi-solid lubricant in which a soap is incorporated in petroleum lubricating oil. There are many different kinds of soaps available to the grease-maker, each of which imparts properties of characteristic nature to the finished product. Sodium soaps, with which all of us come in contact more or less frequently in our desire for cleanliness, when incorporated in petroleum oils results in greases of generally high melting point of a stringy or fibrous nature which ordinarily are not resistant to water. The fibrous nature of the grease is due only to the soap used, no fibers being present. Lime, more properly calcium soaps, which occur as the familiar scum when washing in hard water, being insoluble in water, upon incorporation in petroleum oils, produce smooth, plastic greases for the most part very resistant to water, although having considerably lower melting points than sodium greases. Other soaps of practical value for grease-making are represented by magnesium soaps, zinc soaps, aluminum soaps and lead soaps.

Some petroleum products such as petrolatum, waxes, cylinder stocks or heavy oils, and materials of asphaltic nature, such as gear shields, are sometimes termed greases, owing to their semi-solid form or plastic nature at ordinary temperatures. Such products, however, are not true greases, for, ordinarily, they contain no soap. Claims are frequently made that some grease contains no soap, the claimant perhaps feeling that presence of soap in a grease is in some mysterious way harmful as a lubricant. If the product is of solid or semi-solid form with a melting point over 100 degrees F. and is not a petrolatum, wax, heavy oil, or of asphaltic nature, we may rest assured that it is a true grease and contains a soap of some kind. To the chemist, of course, the presence or absence of soap is simply determined.

Table I is a general summary of the various types of greases, their general composition, and a resume of their

important properties. As such it is self-explanatory.

Greases are needed to satisfactorily lubricate a number of conditions, the more common of which are:

1. Bearings and parts located in out-of-the-way places.
2. Widely variant temperature conditions.
3. Bearings and parts operating in dusty surroundings.
4. Slow speed, high pressure bearings operating reversing or intermittently.
5. Where dripping of the lubricant is objectionable.
6. Badly worn or loose fitting bearings.
7. Exposed gears and slides.
8. Bearings or gears submerged in water.
9. Where frequent attention cannot be given.
10. Where oil cannot be applied easily and economically.

In many of the above cases oil can be used if the proper one can be applied and the consumption controlled. In making a choice it is well to consider that the usefulness of any lubricant depends upon the following factors:

1. Power consumed in overcoming friction.
2. Labor involved for attention.
3. System or appliance required for getting the lubricant to the point needed in the proper quantity.
4. Repairs and maintenance charges caused by lack of proper lubrication.
5. Cost of the lubricant.

Experience has indicated that oil has the advantage of grease on the first count. Oil is usually lower in price on a gallon for gallon basis, figuring an average of eight pounds of grease to the gallon of oil. Grease is usually more economical from the standpoint of the application system required and labor for attention, although each case must be considered separately on this score. The smart engineer will insist upon oil where it can be used and grease where conditions require.

One of the first questions often asked in discussing the choice of a grease for a certain problem concerns the melting point.

Unfortunately, there is no standard method for determining the melting point of a grease. For this reason a general answer is usually given—about 200, about 350, etc. Knowledge of the exact melting point actually would be of little value because of the fact that consistency of the grease at the temperature involved determines its suitability. Greases all become softer with rising temperatures. It cannot, however, be assumed that because one grease is softer than another at room temperature it will be softer throughout a range up to 350 degrees F. or above.

There is no known way of predicting what the relative consistencies may be. The only solution is that of trial. It is, of course, possible to cut short a great number of trials by making use of previously prepared temperature-consistency charts of the available greases. This job naturally falls upon the engineer supplying the lubrication.

Soda soap greases are generally used for high temperature work (over 175 degrees F.). Lime soap greases (cup greases) are not suitable for such service owing to the fact that temperatures near the boiling point of water cause separation of the soap from the oil. Results of such separation are high consumption, oil leakage, carbonization and glazing of the soap remaining behind, and plugging of holes, grooves, etc. The ultimate result is bearing seizure. Anti-friction bearings in particular operating above 175 degrees F., should be lubricated with a high temperature grease containing no lime soap to eliminate danger of soap separation. In such bearings separated soap has the effect of freezing the balls or rollers, causing them in a short time to develop flat spots which are the beginning of the end.

Another common question relates to consistency, especially with relation to uniformity. This is very important where applying devices of any kind are used, for a uniform rate of feed depends to a large extent upon uniform consistency of the grease. Smooth greases are still classified in most users' and many manufacturers' minds by the trade standard, i. e.. No. 1, No. 4 consistency, etc. In the past uniformity of trade standard depended upon the trained sense of touch of the greasemaker—an actual "rule of thumb" test. Although most fiber greases are still "standardized" in this fashion for lack of a satisfactory mechanical measuring device, one large manufacturer of greases for a number of years has been standardizing all smooth greases by means of the ASTM double cone penetrometer. This instrument, which is, no doubt, familiar to many readers, consists simply of a wide cone ending in a steep one suitably mounted in a holder equipped with a dial. The cone is allowed to drop of its own weight into the sample of grease, the depth of penetration indicated on the dial being a measure of the hardness or consistency.

This penetration test can be performed upon the unworked or worked sample. In case these terms are strange, it has been found that although a grease softens upon being worked, i. e., forced through a perforated plate or the hose of a pressure gun, after a certain amount of working it reaches its maximum softness. Because of the difficulty in securing a sample which has not been worked, for even digging out a chunk of grease with a spatula affects the "set" of the product, it has been found that standardization by means of worked penetration is the only feasible way by which reproduceable results can be obtained.

Bear in mind that grease is purchased unworked, but by the time it gets to the bearing its structure is greatly softened. So, after all, the worked consistency is really the important one as far as the behavior of the grease in use is concerned. If greases are made to a definite small range of worked penetration, proper handling of the batch results in uniform unworked greases, familiarly expressed by the trade standard number.

The ASTM penetrometer is limited to consistencies ranging from No. 1 to No. 5. Greases softer than No. 1 are outside the range of the instrument and must be standardized by means of some device which registers plastic flow. Greases harder than No. 5 are very difficult or impossible to work, hence they must be standardized either by unworked penetration or rule of thumb. There is no question that many manufacturers make no attempt to standardize consistencies mechanically. When such a simple way of measuring consistencies is afforded, it is no wonder that buyers alert to the fact are demanding that the greases supplied them be standardized in that way.

The third question commonly heard relates to the neutrality of the grease. Is this grease acid, alkaline or neutral? Very few modern greases are made exactly chemically neutral, although as far as their use is concerned and their effect upon bearing metals they are neutral or inert. Most cup greases are finished slightly alkaline. Some other greases, to secure certain necessary properties, are made on the acid side, chemically speaking. One rather hesitates to mention this because the word "acid" to many people causes them to exhibit various attitudes expressive of horror. However, when one realizes that the fatty acids contained in fats and oils used in making greases are very, very inactive compared to sulfuric and other mineral acids which never come within blocks of a grease kettle, this fear proves to be groundless. Actually it has been found that a grease containing the equivalent of 1 per cent free oleic acid has absolutely no corrosive effect upon the metals used in anti-

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Many grease products are obtained in which are incorporated graphite, mica, clay, soapstone, wood fiber, asbestos, ground cork and other materials in addition to soap and oil. These substances are termed fillers because, with the exception of graphite and mica and in some instances, soapstone or allied substances, they are used to load or adulterate, in order to reduce cost of the grease product. Graphite and mica and in some instances soapstone, have their rightful places: that of improving the lubricating efficiency of a grease for a certain specific purpose. They should by no means be indiscriminately incorporated in greases, nor should products containing them be used without weighing the possible harmful effects of their presence. For example, no worse product could be used on an anti-friction bearing than a grease containing graphite, mica, or asbestos. Lubricating engineers and bearing manufacturers are in accord on this subject, yet it is amazing to know of the many cases where such products have been used for such service.

There is only one excuse for the incorporation of clay, wood fiber, asbestos, cork and other fillers of a distinctly non-lubricating nature in a grease and that is to cheapen it. Such materials have no place in a grease lubricant and have been ruled out in many cases by very rigid specifications.

Concerning the use of perfumes, the fundamental reason back of their addition is to hide a disagreeable telltale odor of some of the constituents. A perfumed grease should be looked upon with suspicion, for while it may have been added in many cases to an excellent product made of the highest quality fats and oils to please the aesthetic sense of the manufacturer or to win over a buyer through the stimulation of his olefactory nerves, in most cases perfume is there to hide something offensive. The offensive ingredient may be a rancid fat or a disagreeably smelling oil distillate. In either case the perfume seeks to dress up the product so that it may slip through. Rancid fats should not be used in grease-making because of their general instability and rapid deterioration resulting in production in the grease product of high fatty acid content which may result in bearing corrosion. Untreated oil distillates are also believed to be unstable and are as objectionable as the use of rancid fats, although to a much less degree.

Last, but by no means least, consideration is given to the matter of the viscosity of the oil contained because of its tremendous effect upon the usefulness of the grease product. The statement has been made that a grease is no better than the oil it contains. While not exactly accurate as far as the quality of the grease is concerned, it brings home the fact that the proper bodied oil must be used to obtain desired results in any specific instance. Although a cup grease containing a very light oil may be perfectly satisfactory for some bearings, others operating under entirely different conditions of speed, pressure and temperature may require a grease of about the same consistency, but containing a much heavier oil. This explains the reason for the large number of different greases often required to lubricate the machinery of any one plant. A plant manager once made the statement in discussing this topic that we should be able to obtain one oil and one grease to lubricate all his equipment, which was as diversified as the topics of a political speech. The reply was made that no sensible person would attempt to drive a railroad spike with a tack hammer. Since then this man has been the direct cause of the addition of four grease products to an already large line.

The automobile of today requires a separate grease for shackle-bolts, universal joints, steering gear, water pump, transmission and differential and wheel bearings. For the car of yesterday, "grease was grease," and a medium consistency cup grease was used for everything except gear lubrication. Today grease is not just grease, but represents a scientifically designed means in many forms for securing proper and adequate lubrication. Grease lubrication to be anything other than a term requires trained men for manufacturing and trained men to choose and apply the best suited product for the condition at hand.

The next article, which will be published in an early issue, will consider methods of application in detail, comments upon the lubrication of various kinds of equipment, and a discussion of the common troubles experienced with grease in service.

Table 1.

Type	Kind of Soap	Soap Range	Oil Viscosity	Melting Point	General Properties
CUP GREASES	Calcium Fat or Fatty Acid	4.0-35.0%	80_{100} - 200_{210}	60-220° F.	Soap separates on melting. Smooth, waterproof. Soften least of all greases upon working. Suitable up to 175° F.
FIBER or SPONGE GREASES	Sodium Fat or Fatty Acid	2.0-35.0%	80_{100} - 200_{210}	60-370° F.	Soap does not usually separate on melting. Stringy, or gutty. Not waterproof. Suitable for service over 175° F., and for special problems under.
MILL GREASES	Sodium Fat or Mixtures	10.0-38.0%	80_{100} - $1{,}000_{100}$	250-380° F.	Soap does not separate on melting. Smooth, hard. Not waterproof. Use restricted principally to cement and paper mills. Temperatures up to 300° F.
RAILROAD GREASES	Sodium Fat or Fatty Acid	40-50%	150 - 200_{210}	380-425° F.	Soap does not separate on melting. Very hard. Locomotive driving journals and pins. Useful for some high temperature work.
AXLE and GEAR GREASES	Calcium Rosin	2-15%	80_{100} - 300_{210}	Up to 190° F.	Soap separates on melting. Lose consistency rapidly on working. Sticky; very waterproof; smooth. Useful for wagon axles, some open gears, skids and plungers.
GEAR SHIELDS	Usually None	.....	80_{210} - $30{,}000_{210}$	Up to 125° F.	Very adhesive; sticky. Usually smooth. Asphaltic in nature. Useful on all classes of gears, wire rope, cables, etc.
SPECIAL GREASES	Includes transmission greases, air tool greases, etc., which, according to composition, might be included somewhere above. Usually semi-fluid cup or fibre greases, or petroleum products of limited application to a great many uses.				

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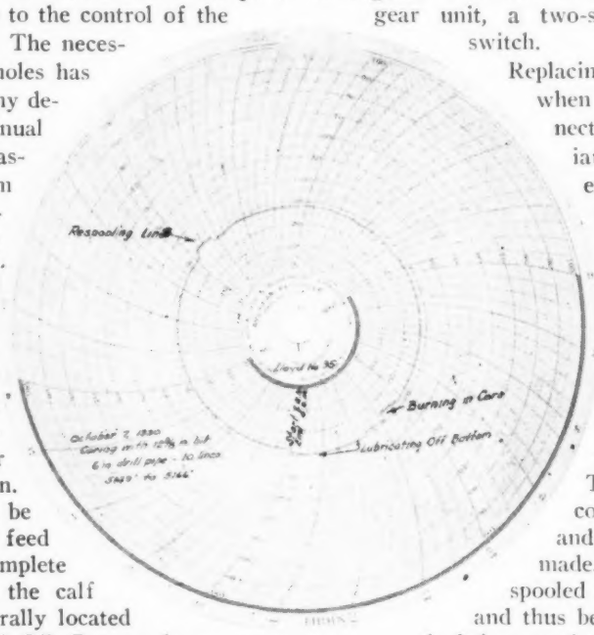
Use of Automatic Drilling Control in California

EQUIPMENT is constantly being designed to facilitate rotary drilling and especial attention has been paid during the past year or two to the control of the weight being carried on the bit. The necessity for the drilling of straight holes has demanded weight control and many devices of both automatic and manual application have done much to assist the driller in this problem which becomes increasingly important as greater depths are penetrated. A new type of automatic control is now in service in the Ventura Avenue Field, California, and is said to be proving satisfactory.

This control is operated by an electric motor, but it is applicable for any type of rig—whether steam, gas engine or motor driven. Electric current must, of course, be available for operating of the feed motor. It is mounted as a complete unit and can be placed where the calf wheel (if such is used) is generally located or, as in the case of Associated Oil Company's Lloyd No. 95 at Ventura, can be set up just off the derrick floor on a side adjacent to the draw works. It can be used in an old rig or on a new one and in this application it was moved in when the well was drilling at 450 feet. It has been used ever since and the hole is now below 5000 feet. A previous test was made with the equipment in the Santa Fe Springs Field where it was used for the partial drilling of a well and where comparisons of the automatic control could be made with hand feeding.



This is a two-hour chart showing the weight carried while core drilling. Note how closely the control is held.

The general arrangement of the equipment can be seen in Figure 1. It consists mainly of a hoist drum, a worm gear unit, a two-speed motor and an automatic switch.

Replacing the calf wheel, it can be used—when automatic operation is disconnected—as a hand-controlled auxiliary hoist, for rigging up, and for emergency purposes when the draw works are out of commission. The motor is a standard 2-speed induction motor of 35/15 HP., 1200/600 r. p. m., 60-cycle, 440 volts. The assembly is mounted on a steel frame and includes a crank and cathead for making-up. An electric control unit is set up at any convenient place.

The operation of the automatic control is indicated by Figures 1 and 2, to which reference will be made. The end of the dead line is spooled for a few turns on the hoist drum and thus becomes a live line. When weight is being carried, there will be a tension in the line and a tendency to rotate the drum. This is transmitted to the worm gear, as shown, and the worm gear then has an end thrust against the thrust, or main, diaphragm. The pressure thus exerted is transmitted by fluid to one column of a mercury U-tube.

An opposing pressure is placed on the other column of the mercury U-tube by air pressure and the two pressures are so set that the desired amount of weight to be kept on the bit will keep the mercury column in equilibrium.

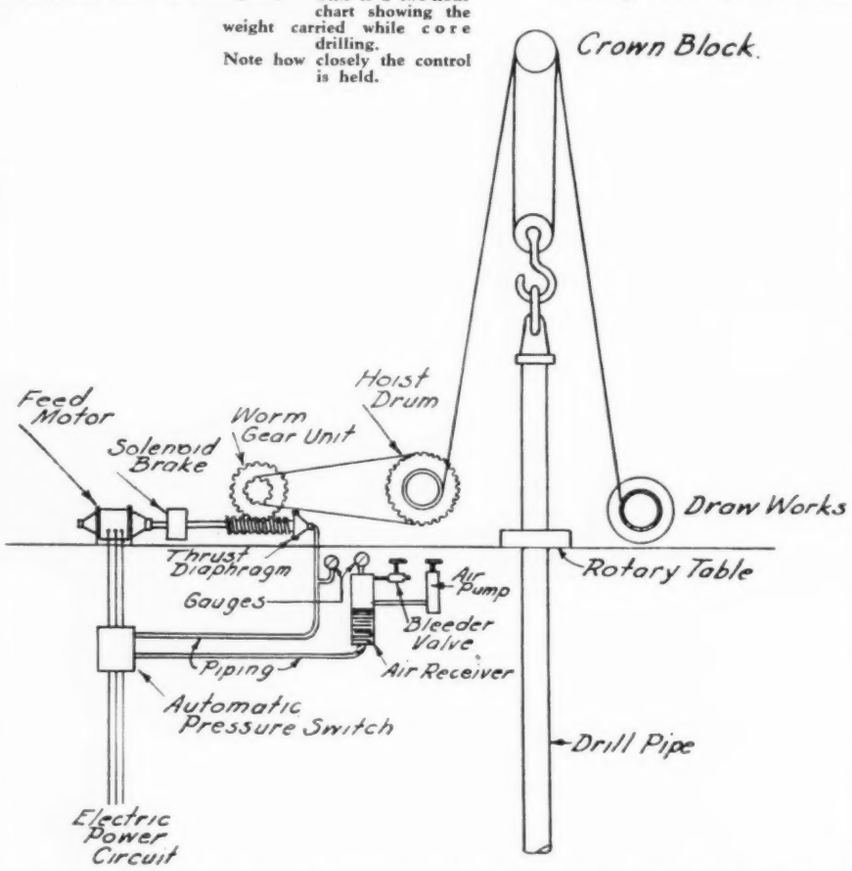


Fig. 1—The general arrangements of the motor feed automatic weight control are shown in this diagrammatic sketch.

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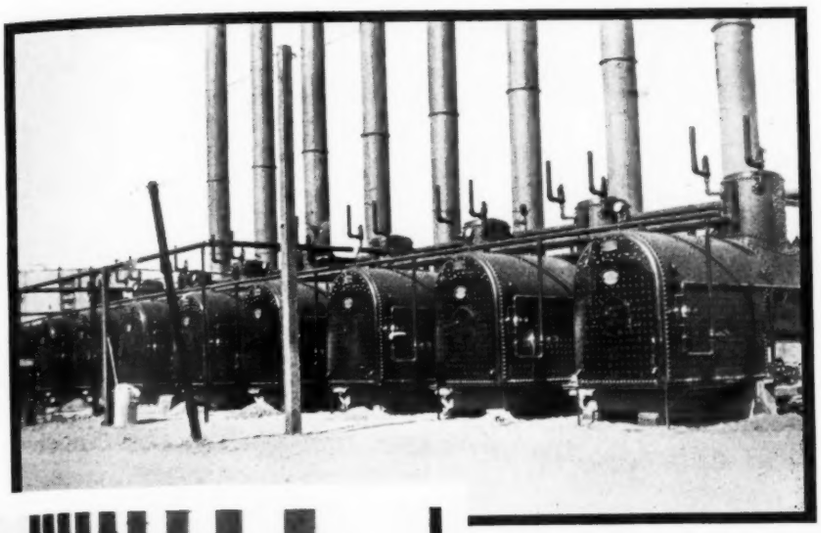

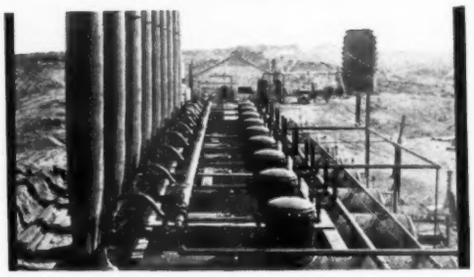

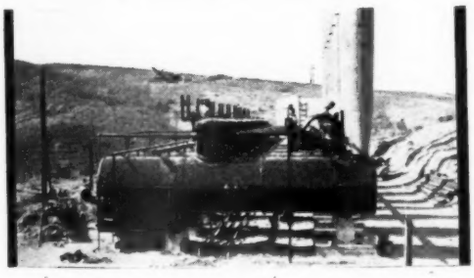

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When the weight changes, even to a very small amount, one column (depending on whether the weight has become too great or too little) will be forced up and make a contact that will set the motor in motion. This will continue until the proper weight is recovered when the mercury will return to equilibrium and disconnect the circuit.

As the bit makes hole, the tension in the line from the crown block to the hoist drum increases. This increases the worm thrust and the pressure on the main diaphragm and forces the mercury down in the right column (see Figure 2) and up in the left until contact is made. This starts the motor to feed the bit down. Conversely, when the weight on the bit increases beyond the desired amount, the tension in the line is decreased. The worm thrust is then lessened and the air pressure forces the mercury in the left column down and that in the right column up until contact is then made. The motor then starts in the reverse direction and retrieves the line until the desired weight is again on the bit.

The motor runs on its slow speed to feed the bit and on high speed to retrieve it. All hoisting is done on the high speed connection whether it is done automatically or by hand control. Although there is a definite on and off action, the mercury switch gives such sensitive control that the line recorded on the chart seldom varies over one point, even during coring operations. Yet the pressure switch is designed to feed the bit only when the average continuous pressure on the bottom of the hole decreases or increases and it does not respond to momentary fluctuations caused by the bit bouncing on an uneven bottom unless they are excessive.

The limit diaphragm as shown in Figure 2 not only acts as a limiting agent for pressure, but also separates the two kinds of fluid used in the fluid line. Water is used to the left of it while tetra-chloride fills the piping from the limit diaphragm to the mercury column. Some tetra-chloride is also used in the air piping at the mercury switch.

Any change in weight setting is made at the driller's position by a few strokes of the pump to increase the air pressure or by bleeding off at the valve shown in Figure 1 to decrease it. This portion of the equipment is placed with the other controls, as is also a hand lever switch by means of which the entire automatic control unit is regulated. By means of this, it is placed in automatic feed, hoisting service, or entirely cut off.

The driller can interrupt the automatic feed at any time either to stop the operation or pick up the bit. This facilitates spudding off a ball. When the line is almost paid out from the hoist drum, it can be respooled either while drilling (by partially releasing the draw works break and so causing the hoist to retrieve the line automatically) or by hand control when drilling is discontinued.

The gauges are, of course, read with an interpretation as used for all weight indicating instruments. When running casing the drum is unclutched from the drive and the crank is run with hand control to operate the jerk line for making up joints. The drum itself is used in connection with its gauge as a weight indicator, but with a dog so placed that it will lock it if anything should occur to make it slip.

When twist-offs occur, the result is the loss of weight which lessens the tension on the line. This causes the air pressure to overcome the fluid pressure and starts the drill pipe above the fracture out of the hole. The automatic control is, of course, of value in pulling a fish since a reaction pressure of any described amount can be set above the balance pressure and the pull of the machine limited to that amount as a maximum.

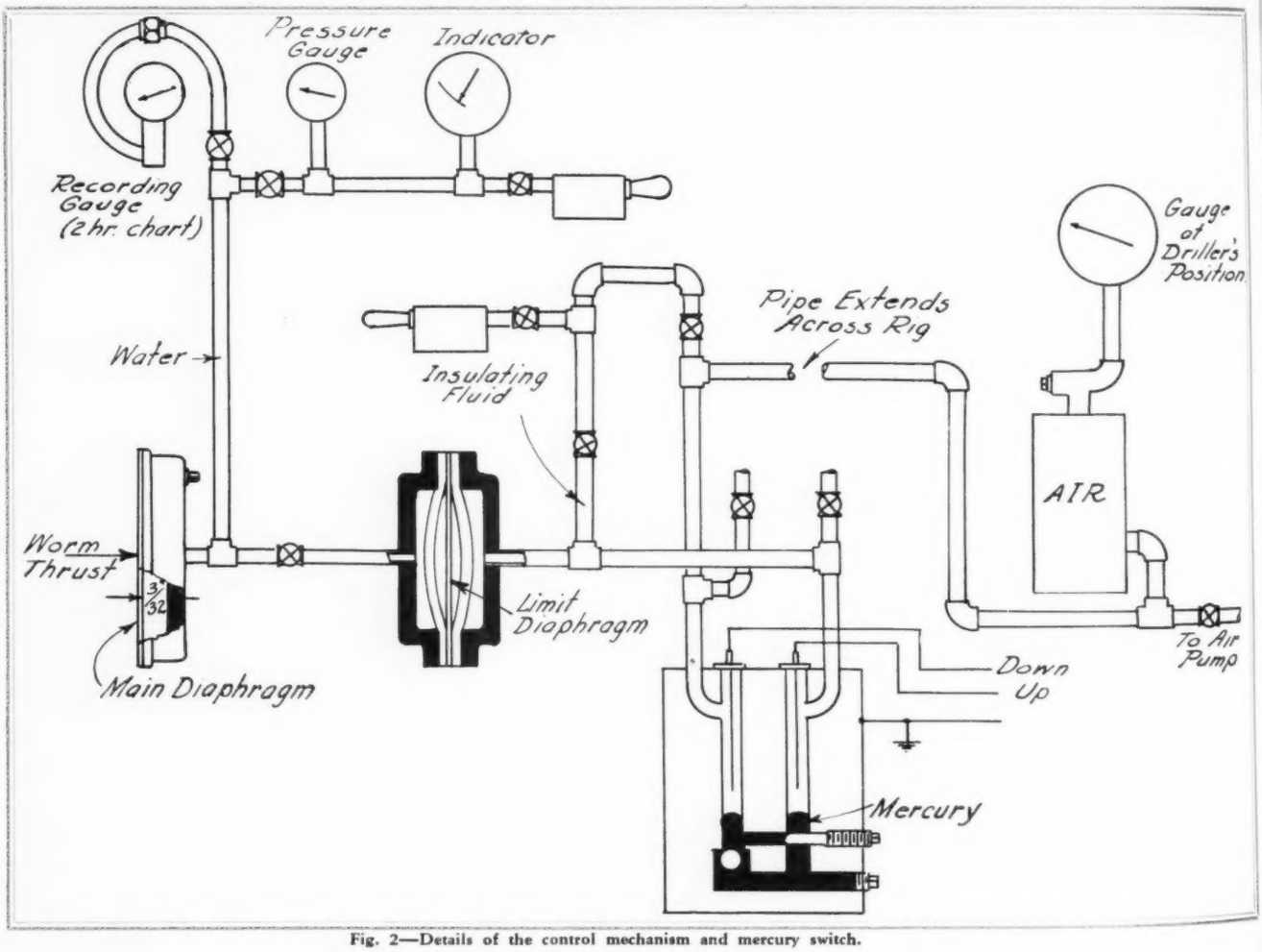

Fig. 2—Details of the control mechanism and mercury switch.

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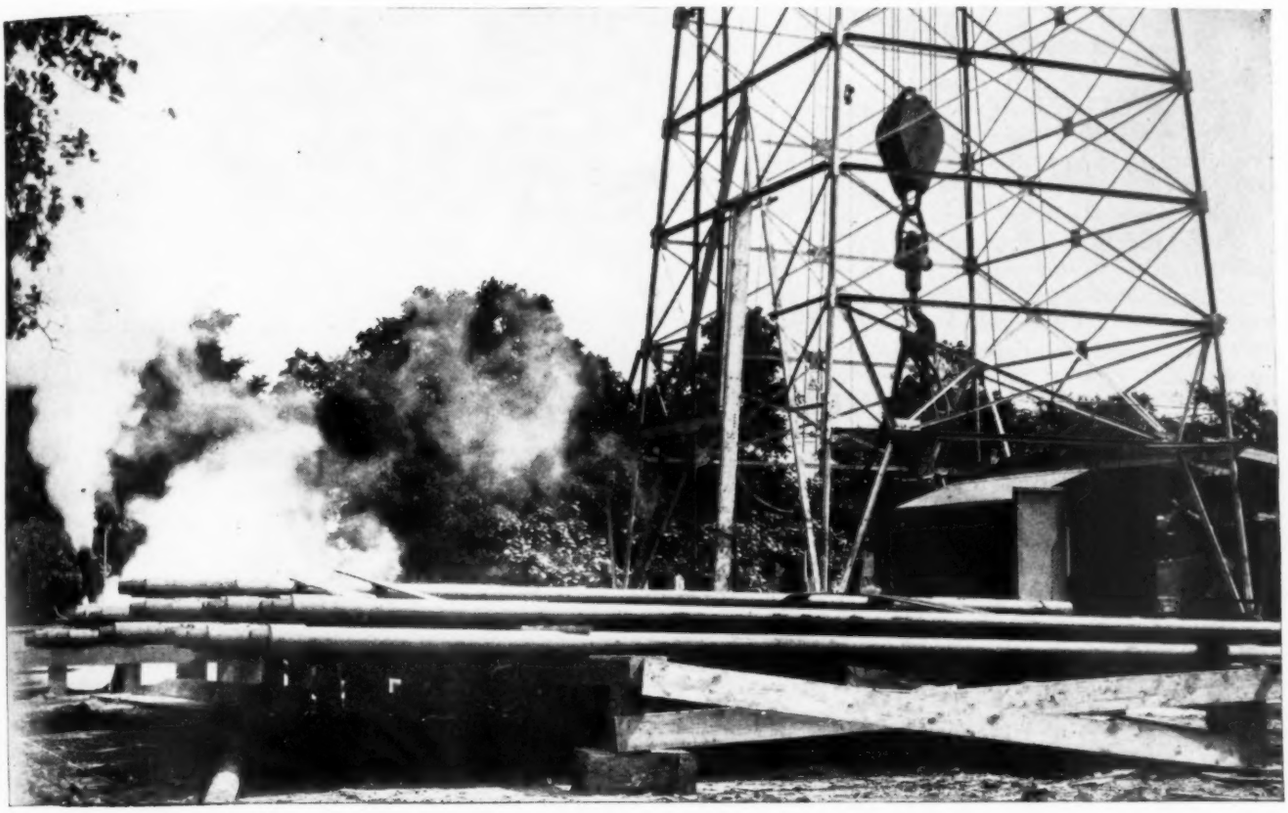

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Oklahoma City Sand Well Shows Good Gas-Lift Results

INTEREST of superintendents and engineers in the Oklahoma City oil field is turning more and more to future means of obtaining additional crude oil production after the natural flowing life of the wells has been spent. Artificial lifting methods—gas-lift and air-lift—are receiving a major portion of this attention.

The principal considerations responsible for turning the attention of the operating men from the development phases to future producing methods have been the decline of pressures to the extent that production has fallen off in many wells to very low points and a continuing decline in the number of drilling operations. With the exception of the north end of the pool there is very little drilling and no prospects are evident at this time for any increased activity.

There are about 57 wells in the entire pool that are being produced by the artificial lifting method. Practically all of these are in the lime producing area, which covers the central part of the field, the first region developed, and which shows the greatest decline in pressures and production. While results obtained in the lime wells are generally considered satisfactory, they have not been sufficient to cause operators to adopt the method for widespread use this early in the field's life.

Recently some of the producers in the sand horizon have been placed on the artificial lifting method of production. These wells have all been on the edges of the pool, where production has been much smaller than in other parts of the area. If some of the results obtained are even proportionally duplicated throughout the sand producing areas the Oklahoma City field will be a larger producing factor in the crude oil market next year than previously anticipated. Most of the operators are quite hopeful that the entire sand producing area may be successfully produced by the artificial pressure lifting method when the natural pressure is depleted.

Sand areas have always been considered better adapted for gas-lift than lime-producing areas, and the developments in the Oklahoma City field are not surprising. The most important and surprising development thus far has been the degree of efficiency obtained in these wells, which are 6,400 feet deep.

The Indian Territory Illuminating Oil Company has an outstanding example of gas-lift efficiency in its first well in the sand-producing district to be placed on this type of flowing method. The well, Nettie Emerson No. 9, is located in the south end of the field, where the producing horizon never had much gas, and where the gas is now almost depleted. Production of the well has been practically doubled by the application of the gas-lift method of flow. Its production is averaging about 4,350 barrels per day at this time.

The working pressure averages 400 pounds, with the kick-off pressure slightly higher. This well is tubed with two and one-half inch tubing, set inside of the seven-inch casing. The tubing was originally set at 5,000 feet, but has now been lowered to a total depth of 6,000 feet. The fluid level in the well is approximately 5,000 feet. The gas is being injected into the hole down the tubing and the oil flowed up the annular space between the casing and tubing.

The Oklahoma City field, right now, offers unusual obstructions to the engineer or superintendent attempting to experiment in producing methods because of the heavy restrictions on crude oil production. Less than three per cent of the potential is being taken daily. The field is being prorated on the time basis; that is, each well is given an allotted period of time to flow each month. The time is so short that when the men have succeeded in finding the best flowing condition it is usually time for the well to be shut in again. Then the next month, at its allotted period of production, the condition of the well has been so changed by the producing of offsets at various times during the month, that efforts to find the best flowing condition must be renewed. Thus all data and experiments must be carried on for only a short time on each well, after which they must be dropped for another month.

The near future, bringing additional decline in pressures and drilling wells, will doubtlessly see a marked increase in the efforts of the various companies to adapt gas-lift and other methods of producing to the deep Oklahoma City wells. Upon the success of such work will largely depend the ultimate recovery of the pool.

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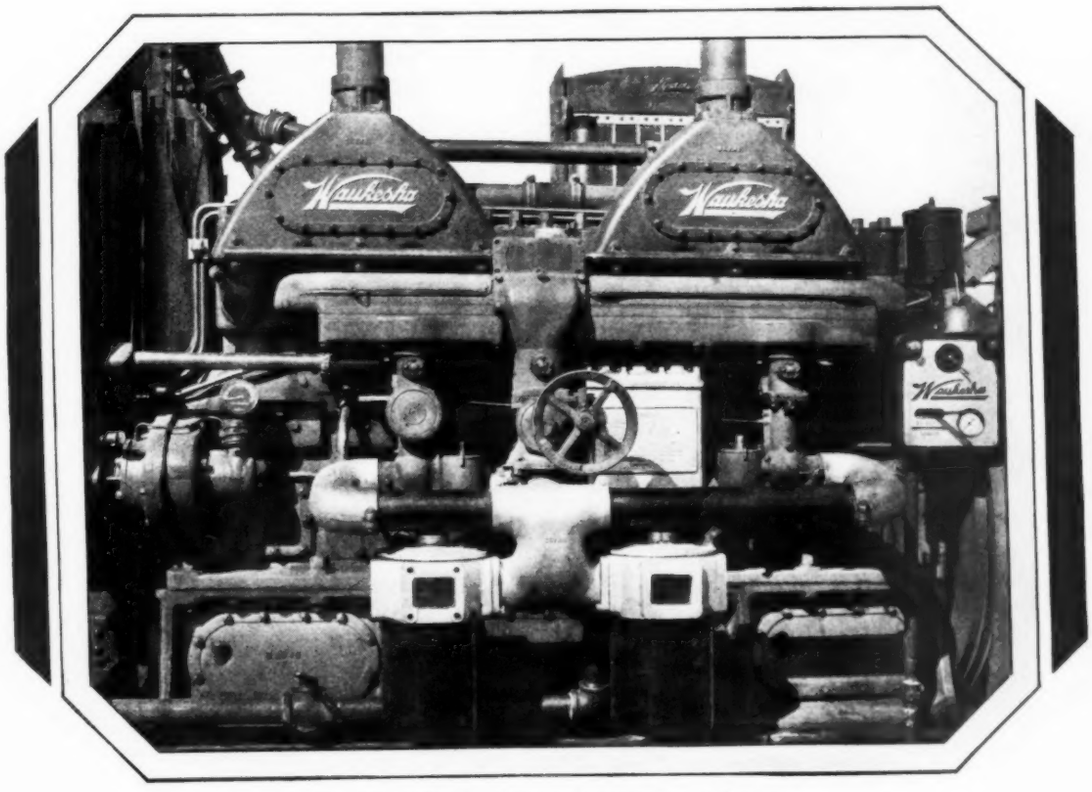

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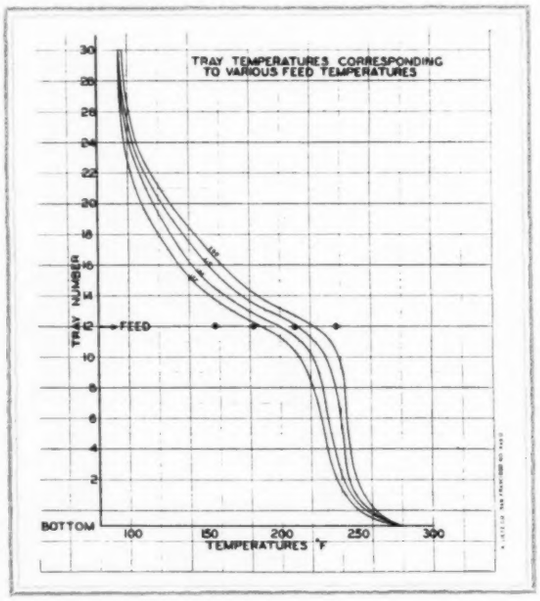
Natural Gasoline Fractionation and Distillation

By NORMAN C. WELLS, *Gas Engineer, The Texas Company*

THERE are two reasons why light hydrocarbons are not desired in finished gasoline. They vaporize readily and in so doing carry with them heavier, desirable hydrocarbons, thus causing high weathering and transportation losses. They will vaporize to cause "gas-lock" in the carburetor of a gasoline engine, thus causing sudden loss of power.

To absorb as much as possible of the desired gasoline from natural gas, until selective absorption is perfected, much of the undesirable portion must be included. Fractional distillation processes are more selective than absorption and so the burden of selectivity is shifted in this direction. Two fractionations are generally resorted to, one separating the absorbed gasoline from the absorbent, the other separating the lighter fractions from the product to meet desired specifications.

The simplest unit of processing equipment in the absorption plant is probably the final fractionator. In it the final fractionation of the finished product is accomplished, removing the light, undesirable hydrocarbons from the desirable. It is the simplest because it deals principally with hydrocarbons of known properties. The fraction that is removed from the product is of simple composition. To better understand the action of the absorbers, and the distillation and fractionation of the absorption oil, it is well to first consider the operation of the rectifier. Most present-day specifications for natural gasoline for blending to yield motor fuel call for a product free from methane, ethane, propane and isobutane. For aviation gasoline all but a small portion, 4 per cent or 5 per cent, of normal butane is also removed. The following example shows such a cut, giving the percentages by liquid volume of each constituent:



	Feed	Product (Aviation)
Methane	0.1%	0.0%
Ethane	0.6	0.0
Propane	4.0	0.0
Iso-butane	10.8	0.0
Normal butane	10.2	4.3
Pentane and heavier	74.3	95.7

The lighter hydrocarbons have been removed without losing any pentane or heavier constituents. The final fractionator consists essentially of a column of trays with a means for heating at the bottom and a means for condensing at the top. The gasoline is fed into the column at some intermediate point. As it gravitates to the bottom some of it is boiled off by the hot rising vapors. Each tray acts as a combined condenser and boiler at one time. The hot vapors coming from below strike the relatively cool liquid on the tray, condensing some of the heavier elements in these vapors. The heat given up by this condensation boils off some of the lighter constituents of the liquid on the tray.

When this is done in a series of trays a very efficient separation is secured and the lighter (undesirable) constituents of the feed are separated from the heavier (desirable) ones without any loss of the latter. These lighter constituents constitute the "excess overhead" and are taken to the dry gas line.

The accompanying sketch shows a popular general type of final fractionator used. Another type has the condensing section at the top and the amount of reflux condensed is controlled by the water to the condenser.

Under perfect conditions the overhead would be uncondensed vapor. The condensate would be of slightly "heavier" composition and would continually be recycled (condensed, pumped back into the top of the column, vaporized in the trays, condensed, pumped back, etc.). However, the plant is flexible and will withstand slight changes of conditions (temperature, pressure, etc.) if a slightly excessive amount of the overhead is condensed. This will keep a little vapor and a little liquid going to the dry gas line as excess overhead. To prevent freezing it is desirable to vaporize this liquid with a steam jacket or some other device.

As more liquid is added to a tray, more vapors will be condensed by it and also more vapors will be boiled off. Thus, increasing the reflux rate will increase the amount of liquid on the top trays and cause them to effect a better separation. This will cause each tray to have a "lighter" composition and increase its vapor pressure. A new condition of equilibrium will be established at a greater pressure, the vapor pressure of each tray, as well as that of the kettle and reflux accumulator, being increased. Temperatures will stay substantially the same unless some compensation is made by the operator.

Now, if the pressure cannot rise because it is held constant by a back pressure regulator, the increase in vapor pressures will cause more vapor to form and the back pressure regulator will allow more to vent. The column cannot reach its new "equilibrium" and the reflux will vaporize and pass out through the regulator. This will continue until the reflux pump loses suction and then no liquid will be going over into the top of the column. The trays above the feed will go dry and the hot vapors from the feed tray will go directly to the condensers. The reflux will sud-

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denly become a fairly heavy gasoline and the fractionating effect of the column will be destroyed.

In normal operation, a measure of this "fractionating effect" is secured from the temperature gradient or difference in temperatures between trays. At a constant pressure the lighter constituents of each tray will boil off at a lower temperature than the tray below. Ordinarily the lower trays will show a greater temperature difference between trays than the higher trays. If the column is operating as desired, a slight temperature difference between the two top trays indicates that the fractionating effect of the column is not overloaded, and vice versa. Hence, the more trays the greater the fractionating effect that can be secured or the less the amount of reflux that will be required.

The column may be overloaded in another manner. Where the fractionating effect deals with quality, this other degree of load deals with quantity. If the vapors passing up reach such a velocity as to carry the liquid with it, the column will "carry over" or "prime." The same effect will result from too large volumes of liquid passing down from tray to tray, causing an overload of the liquid passages.

At higher pressures, then, the column will have a greater capacity both from the standpoint of quantity and fractionation. This is due to the fact that the rising vapors will contain more molecules per cubic foot. In other words, under the influence of pressure the individual particles comprising the vapor will be packed more closely together in a unit space.

In selecting the scale of temperatures and pressures at which to operate, the governing factor is normally the performance of the condensers. Assuming equilibrium in the reflux accumulator, the column pressure would be the vapor pressure of the reflux at the temperature to which it is cooled.

Assuming equilibrium in the kettle, the kettle temperature should be such as to maintain this pressure with the desired product as to vapor pressure.

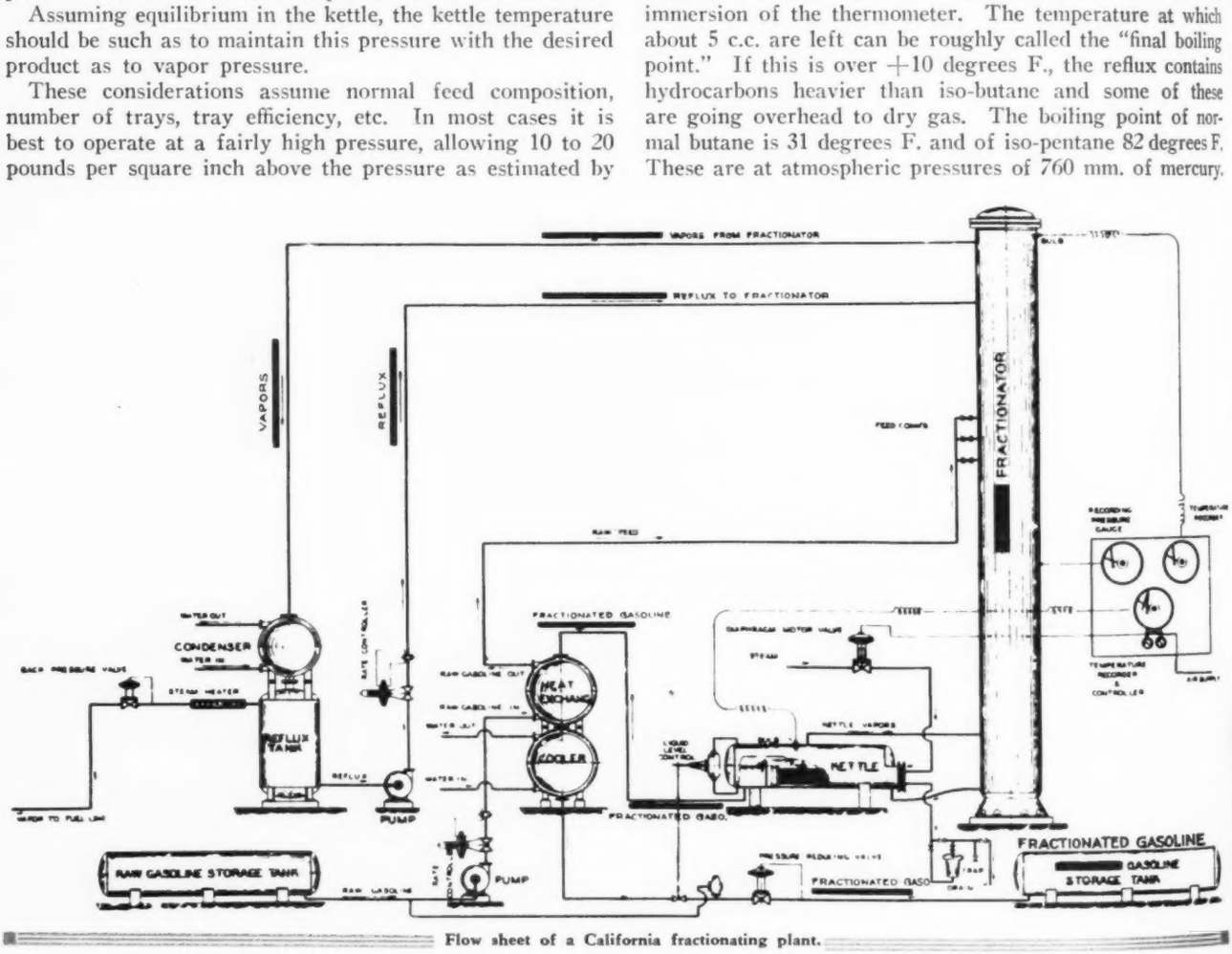
These considerations assume normal feed composition, number of trays, tray efficiency, etc. In most cases it is best to operate at a fairly high pressure, allowing 10 to 20 pounds per square inch above the pressure as estimated by the above method. This will allow for changes in feed composition, etc. Also, in most cases, it will reduce the reflux rate and hence the steam consumption.

To stay within easy range of average cooling tower efficiency as to condenser operation, final fractionator pressures ordinarily run from 175 to 200 pounds per square inch gauge. To operate at substantially lower pressures would lead to extremely low top temperatures with consequent freezing of entrained water. It would also necessitate the use of a refrigeration system of condensing. In addition, there would be the relative tray inefficiency, as already explained.

The temperature of the feed should be approximately the temperature of the tray on which the feed is introduced. The accompanying curves indicate the relative effect of feed temperatures feeding to tray 12. A temperature of 210 degrees F. appears best for this feed point. Higher temperature reduces the fractionating efficiency, as indicated by the trend of the curve at the top of the column.

By far the most satisfactory method of control is to take fundamental analyses of feed, product and overhead, together with volumes and column conditions. This cannot be done frequently, because of the expense involved, but if a thorough analysis is made from the results of one good survey and subsequent operations are checked with reflux weathering tests and estimates of fractionating loss, the plant can be operated very efficiently.

A rough weathering test can be run by chilling a 100 c.c. graduate with reflux, filling it with 100 c.c. of the reflux and allowing it to boil off, noting the temperatures at various points. Some small allowance should be made for the effect of radiant heat on the thermometer as well as the immersion of the thermometer. The temperature at which about 5 c.c. are left can be roughly called the "final boiling point." If this is over +10 degrees F., the reflux contains hydrocarbons heavier than iso-butane and some of these are going overhead to dry gas. The boiling point of normal butane is 31 degrees F. and of iso-pentane 82 degrees F. These are at atmospheric pressures of 760 mm. of mercury.



Flow sheet of a California fractionating plant.

The Constant Velocity Cycle in Slow-Speed Pumping

By C. L. MOORE*

SLOW speed pumping of small wells in California is becoming widely adopted as the cheapest and easiest method of lowering lifting costs on such wells, so that they will return a profit in spite of the low prevailing prices for crude.

Entire leases and in some cases almost entire fields have been slowed down to 5 to 10 strokes per minute, and many individual wells are operating at 3 strokes per minute or less.[1]

Several thousand small wells have been producing for years in the San Joaquin Valley fields and lifting costs have been of prime importance in these fields as well as many other fields in California.[2]

In the past, head-well pumping has been generally resorted to with small, unprofitable wells, in a final effort to produce them at a profit before abandonment. This method usually failed of satisfactory results, as maximum recovery from the unconsolidated, low pressure sands in California, requires continuous drainage which cannot be secured when the well is shut down part time; nevertheless, head-well pumping was the usual procedure throughout California fields at the time experiments with slow-speed pumping were first started by this company in the Midway-Sunset District in 1926.

These initial experiments were based on Uren's theory of critical fluid levels in pumping wells, published in 1925.[3] In this paper, Uren ably demonstrated the necessity for maintaining a certain critical fluid level in every pumping well in order to secure the maximum rate of drainage into the well. This theory naturally implied slowing down pumping wells until the pump displacement would approach the maximum rate of drainage. This was done on several wells, and very substantial reductions were made in operating costs, but in no case was a production increase secured in accordance with Uren's theory, and even small decreases were noted on some wells. This condition is still generally true on slow-speed wells in California, except where operators have recognized the basic soundness of Uren's theory and applied it in accordance with the supplementary principles presented herewith.

This paper covers the results of investigations carried on under the supervision of Mr. C. L. Moore during the past five years in the San Joaquin Valley fields. It is of immediate interest to those confronted with the problem of lowering lifting costs on small wells, as it points to a possible solution of pumping small wells at a reasonable profit in these days of prevailing low crude prices.

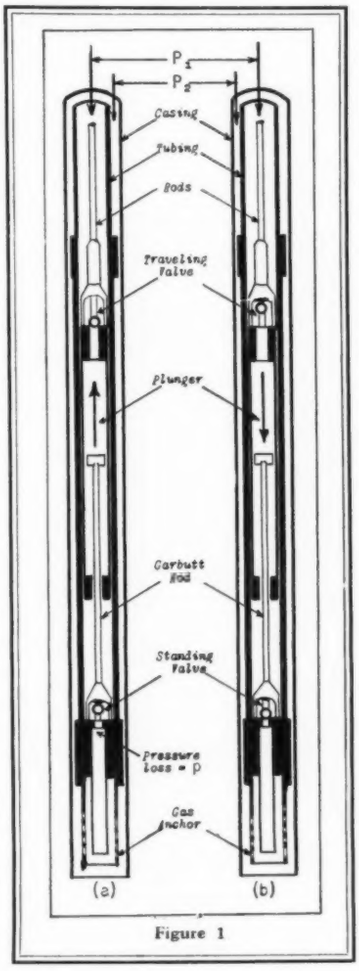


Figure 1

In casting about for an explanation for the failure to secure the production increases from slow-speed pumping as anticipated by Uren's theory, the writer studied the work of Beecher and Parkhurst on the solubility of gas in oil.[4] Although this work was done for an entirely different purpose, a study of the methods used and results secured, led the writer to conclusions which had an important bearing upon the problem at hand. A short discussion of the action of the standard plunger pump used in oil-well pumping, will be necessary, to present these conclusions.

Figure 1-a shows the plunger on the up-stroke. The standing valve is open and oil is entering the barrel under the submergence pressure P_2. Due to the resistance of the standing valve, the oil inside the barrel on the up-stroke is under a lesser pressure than that outside the barrel. We will designate this differential or pressure loss by p. This pressure loss results in the formation of free gas within the barrel, even though the gas anchor is one hundred per cent efficient, and no free gas enters the barrel. A study of Beecher and Parkhurst's experiments will prove this statement, for the oil entering the barrel is saturated with gas due to the submergence pressure P_2, and they found that any drop in pressure on such saturated oil would immediately result in the expansion of gas from the oil. Therefore, at the end of every up-stroke there are always bubbles of free gas throughout the oil in the barrel. Figure 1-b shows the plunger on the down-stroke. The standing valve is now closed, the upper or traveling valve is open, and the gas-oil mixture in the barrel is being displaced into the

* Engineer, Chanslor-Canfield Midway Oil Company, Fellows, California.

[1] "Electrical Pumping Equipment in California," by R. N. McMaster, Petroleum Engineer, Vol. 1, No. 9, Midyear Number, 1930.

[2] "Economical Production of Small Wells," by Allison C. Dyer, presented before the American Petroleum Institute, Los Angeles, Cal., June 27, 1929. Published in National Petroleum News, July 10 and July 17, 1929.

[3] "Significance of Fluid Level in Oil-Well Pumping," by Lester C. Uren. New York meeting, A. I. M. & M. E., February, 1925.

[4] "Effect of Dissolved Gas Upon Surface Tension and Viscosity of Oil," by C. E. Beecher and I. P. Parkhurst. Presented AIM&ME at Tulsa, Oklahoma, October 11-12, 1926. This work was done primarily to test the contention of Mr. Henry L. Doherty, that the oil in the formation was of much lower viscosity and surface tension than when produced at the well head, due to the dissolved gas, and that therefore existing production methods were wasteful as the gas did not do its full duty in draining oil to the well. This contention was fully proven by the work of Beecher and Parkhurst and also that of Dow and Calkin, and is now generally recognized throughout the industry. See "Solubility and Effects of Natural Gas and Air in Crude Oil," by D. B. Dow and L. B. Calkin, U. S. Bureau of Mines, Reports of Investigations, Serial No. 2732.

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tubing. Under these conditions the oil in the barrel is under the much greater pressure P_1, due to the column of oil in the tubing clear to the top of the well. It is natural to assume this greater pressure would put the free gas in the barrel back into solution; however, a careful study of Beecher and Parkhurst's paper, particularly the portion describing the apparatus and methods used, reveals the fact that this reverse phenomenon of putting the gas back into solution requires considerable time plus agitation, and it was the writer's conclusion there was not sufficient time or agitation on the down-stroke to put this gas back into solution on the slow-speed pumping experiments which he had undertaken up to that time. This phenomenon results in the presence of free gas in the oil remaining in the barrel at the end of the down-stroke, and this free gas is compressed under pressure P_1 to much less than its original volume on the up-stroke. Therefore, it must be expanded on the next up-stroke to a volume corresponding to a pressure P_2 minus p before additional oil can enter the barrel. It is readily seen that as the well continues pumping this effect is cumulative, resulting eventually in the expansion and contraction of a slug of free gas in the barrel, and the pump is gas-locked. Careful observation of the slow-speed wells being experimented upon verified this theory and explained the failure to secure any production increase in accordance with Uren's theory of critical fluid levels.

In November, 1926, the problem thus presented of successfully applying slow-speed pumping to secure not only lowered costs but increased production, was submitted to H. H. Dyer[5] and he undertook the solution of it. A preliminary analysis of the problem

[5]H. H. Dyer, Engineer, Los Angeles, California.

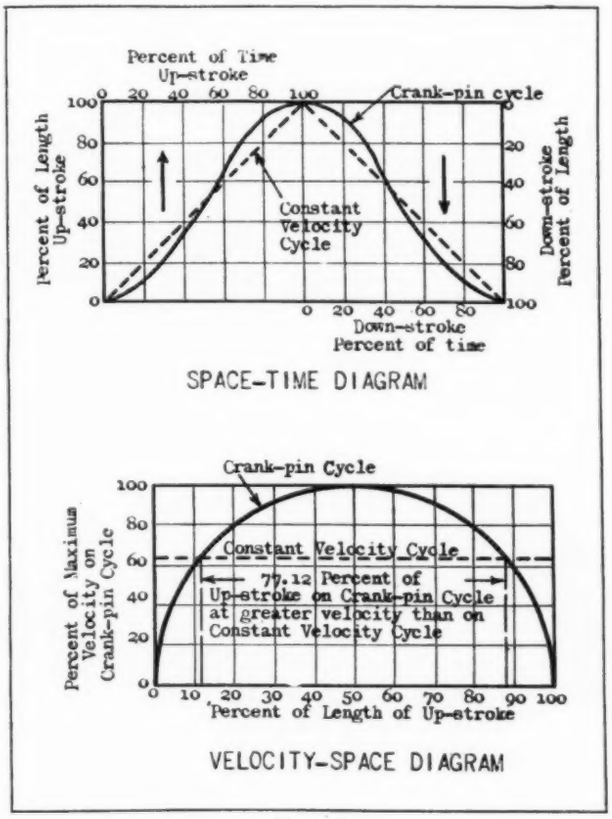


Figure 2

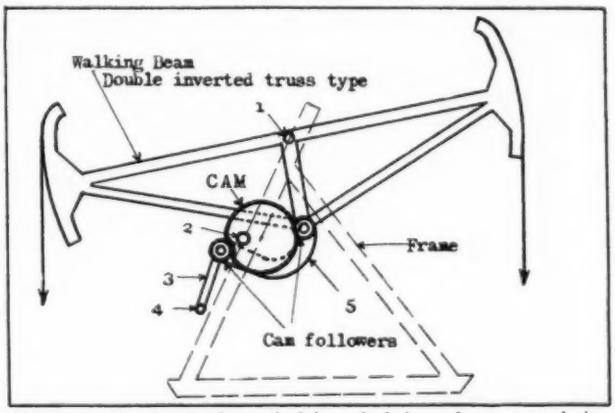


Figure 3—Sketch showing principles of design of constant-velocity cycle pumping unit by H. H. Dyer. 1, Walking beam pivot; 2, cam shaft; 3, rear cam follower lever; 4, lever pivot; 5, cam follower connecting link.

Figure 5—Partial view of experimental constant-velocity cycle pumping unit, showing operation of hand wheel which provided instantaneous variation of pumping speed from one-half stroke to seven strokes per minute.

showed the amount of expansion in the barrel on the up-stroke (assuming no gas lock condition) varied directly as the pressure loss and inversely as the submergence. It appeared likely that if one or both of these factors could be changed sufficiently to effect a material reduction in the amount of expansion, that the reduced volume of free gas developed in the barrel would be put back into solution on the down-stroke and gas lock would be eliminated.

As the pumps in these small wells were already placed as low as possible, and as the maintenance of a critical fluid level was an inherent requirement of the slow-speed program, the matter of submergence was beyond control. Attention was then directed to the pressure losses and a thorough study made, resulting in the following conclusions:

1. Pressure losses could be controlled within certain limits by the standing valve design, but it was found the standard designs on the market were about as efficient as could be devised, and also were simple and dependable, which is a proven asset in subsurface equipment.

2. Pressure losses increased rapidly with increases in the viscosity of the oil, which was beyond control.

3. Pressure losses increased directly as the velocity of the fluid through the standing valve[6], which is controlled by the rate of pump displacement or velocity of the plunger.

The third conclusion, involving plunger velocities, appeared to offer a solution

[6]This assumes sinuous flow, which is the condition in slow-speed pumping. At higher pumping speeds turbulent flow is present, when the pressure losses and consequent expansion will increase as the 1.25 power to the square of the velocity. This indicates that the constant-velocity cycle should show a marked increase in volumetric efficiency and production at the greater pumping speeds used on larger wells.

and Dyer concentrated his efforts on this phase of the problem. It was found that the plunger velocity for about seventy-five per cent of the crank-pin cycle commonly used on surface pumping equipment was greater than the required average velocity, and it was evident a pumping mechanism having a constant-velocity cycle would hold the plunger velocity to a minimum and effect a substantial reduction in the pressure loss and expansion in the barrel. Figure 2 shows space-time and velocity-space diagrams of the crank-pin cycle compared to the constant-velocity cycle and indicates the reduction of maximum plunger speed effected by the constant-velocity cycle.

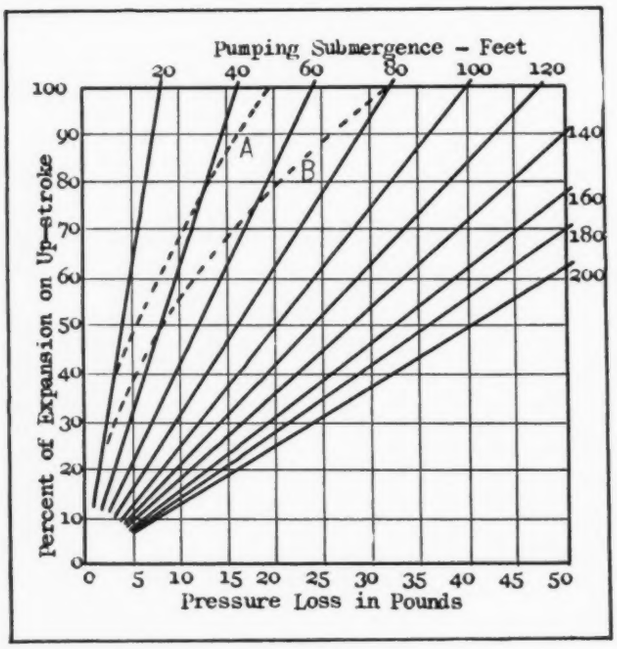


Figure 7

In 1927 Dyer designed a constant-velocity cycle pumping unit, the principle of which is shown in Figure 3. The actuating member is a modified type involute cam which gives a constant velocity to the plunger over eighty-four per cent of the stroke, the balance being taken up in acceleration and deceleration of the load.

The design is such that the maximum acceleration, and consequent dynamic loading on the rods, does not exceed that of the crank-pin cycle. The cam is double-acting in that it imparts a positive up-and-down motion to the beam, providing one hundred per cent counterbalancing and equalizing the load on the prime-mover throughout the entire up-and-down stroke. This eliminates the peak load common to crank-pin cycles and enables the operator to use a smaller motor, thereby reducing power costs and increasing efficiency and power-factor.

Arrangements were made for the construction of an experimental unit, which was delivered to this company and put in operation in the Midway district in January, 1928. This experimental unit was equipped with a special drive consisting of a Reeves variable-speed transmission, whereby the pumping speed could be instantly varied from one-half stroke to seven strokes per minute. (See Figure 5.) This unit has been operated on a number of wells of different types in San Joaquin Valley fields, and a vast amount of empirical data have been secured from these tests. They have completely confirmed Uren's theory of critical fluid levels, as production

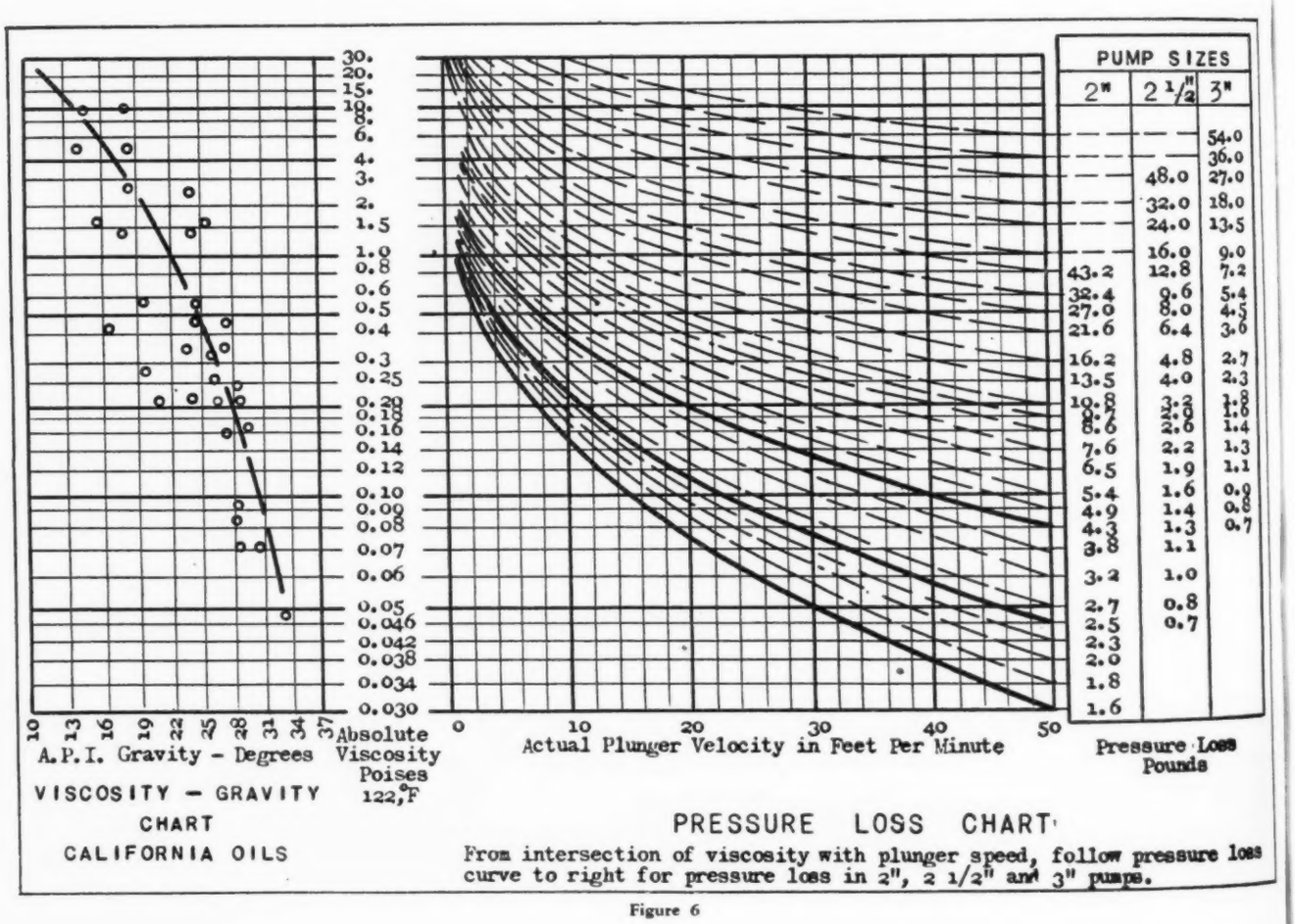
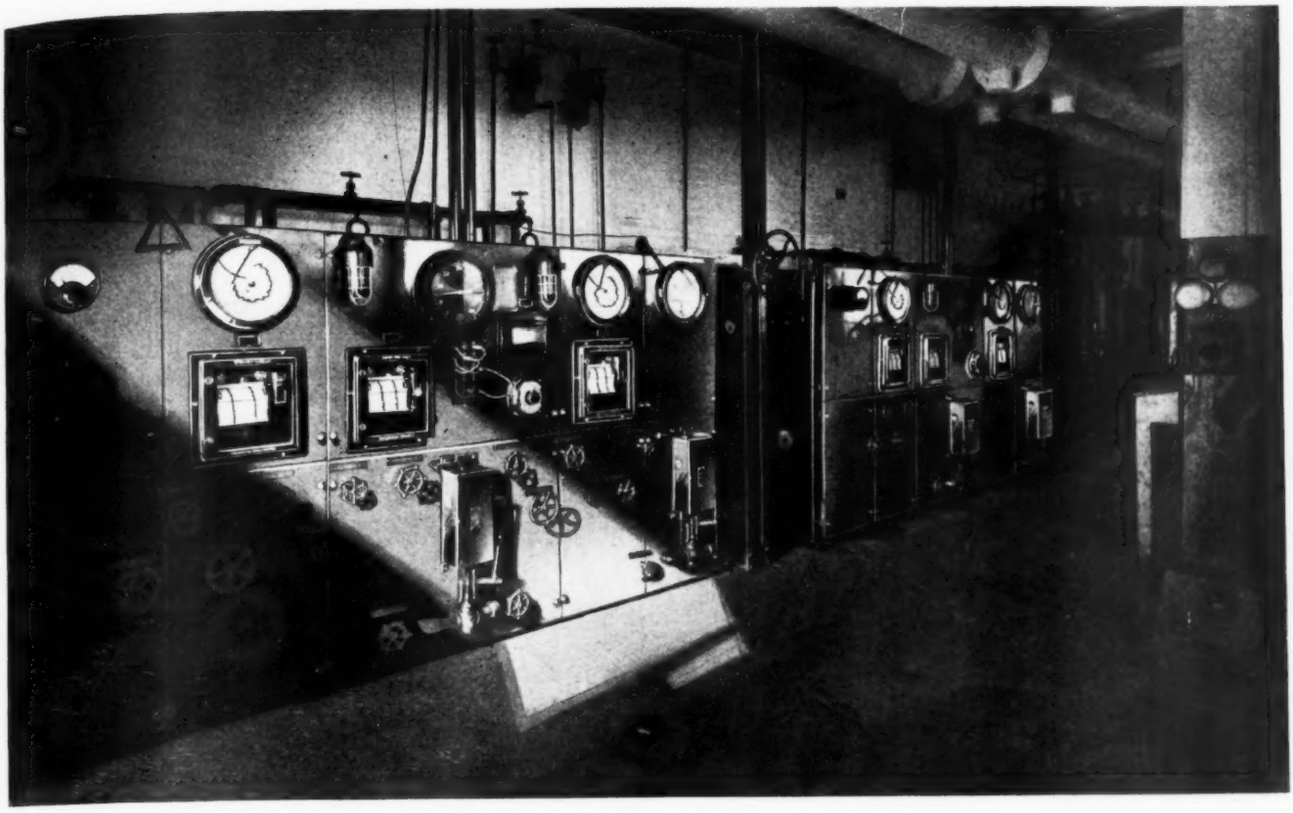


Figure 6



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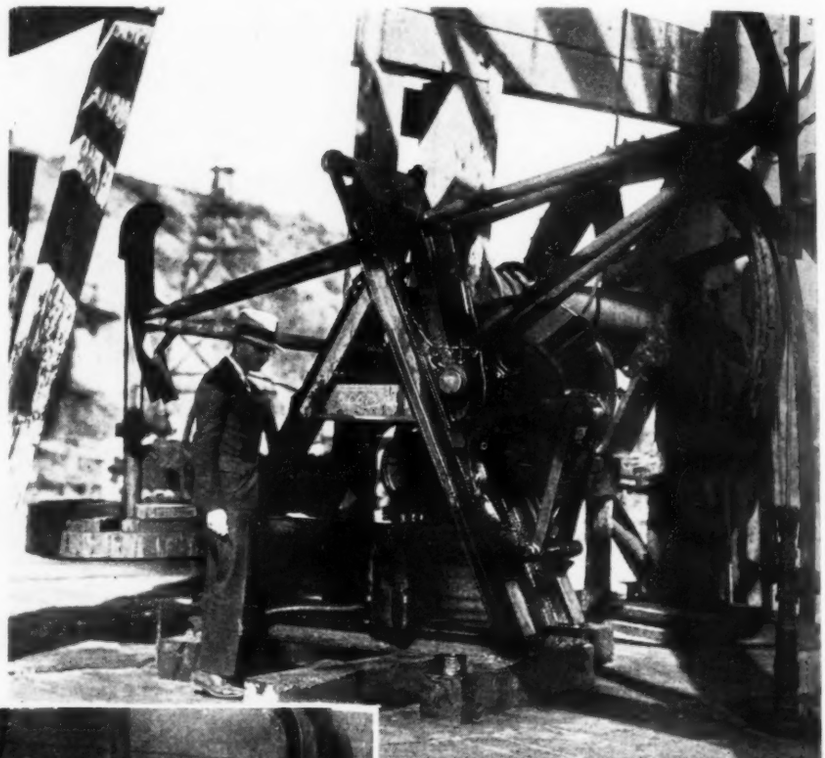
increases up to three hundred per cent have been secured. Also, the data derived from these tests have amplified the supplementary principles given in this paper and furnished an empirical guide to the computation of pressure losses in 2-inch, 2½-inch and 3-inch plunger pumps at various viscosities and plunger speeds.[7] These values are shown in Figure 6, together with the indicated variations in viscosity of California oils by gravities.[8]

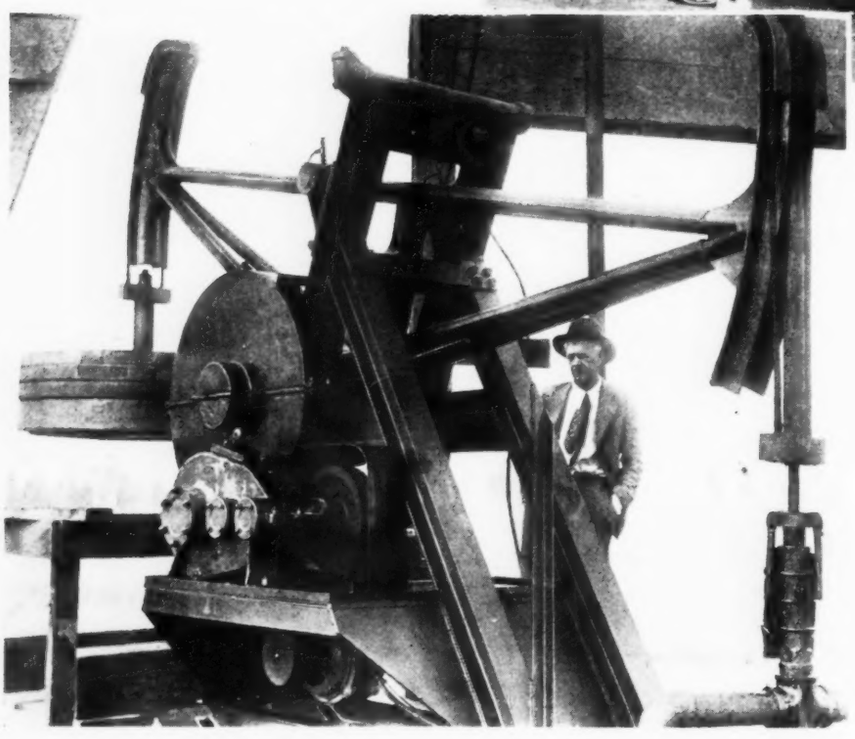
Referring to the pressure-loss chart in Figure 6, it is noted the pressure-loss curves cut the vertical velocity ordinates at a much steeper angle for plunger velocities up to 20 feet per minute than for higher plunger velocities. This indicates that on wells operating up to four or five strokes per minute it is imperative that the plunger velocities be kept to an absolute minimum, showing the greatest differential in favor of the constant-velocity cycle on these slower speed wells. Among the important things discovered through the tests with the experimental unit is the fact that for a given viscosity there is a minimum plunger velocity for the different size pumps, below which the standing valve is not maintained in an open position, due to the velocity of the incoming fluid being too low to suspend the ball off the seat. Sufficient empirical data were secured to compute the values of these minimum velocities and they are shown by the heavy solid lines on the pressure-loss chart and mark the minimum plunger speeds at which the different size pumps can be successfully operated.[9] This condition gives an added advantage to the constant-velocity cycle, particularly on wells operating within twenty-five per cent of these minimum speeds, as the proportion of the stroke in which the plunger velocity is below this minimum value is greater on the crank-pin cycle than on the constant-velocity cycle. When the plunger speed is below this minimum value, the ball is probably fluttering on the valve seat, resulting in additional gas expansion.

Figure 7 shows the per cent of expansion resulting from pressure losses up to fifty pounds, for pumping submergences from 20 to 200 feet. Curves A and B show limiting values for expansion from the total gas in solution at given pumping submergences based on the solubility tests of Beecher and Parkhurst and Dow and Calkin. Curve A is based on the maximum solubility found and Curve B on the minimum. In converting pounds pressure to feet of submergence, a fluid

[7] The computation of Pressure-Loss Curves is based on Poiseuille's formula for sinuous flow, the necessary constants having been derived from actual test data.

[8] The data for the Viscosity-Gravity Chart were taken from "Properties of Typical Crude Oils From the Producing Fields of California," by A. J. Kraemer and H. M. Smith, Bureau of Mines, Reports of Investigations, Serial No. 2295; and Bacon and Hamer, "The American Petroleum Industry," Vol. 1, p. 131. Conversion to absolute viscosities in poises from the Saybolt seconds and Engler degrees given was made by means of conversion chart in International Critical Tables, Vol. 1, p. 33, and the conversion of these values to the corresponding average well temperatures assumed at 122 F. was made by chart in International Critical Tables, Vol. II, p. 147. In wells having pumping submergences of 100 to 200 feet, there is a 5 to 15 per cent reduction in absolute viscosity due to gas in solution, and this allowance should be made when using the chart.

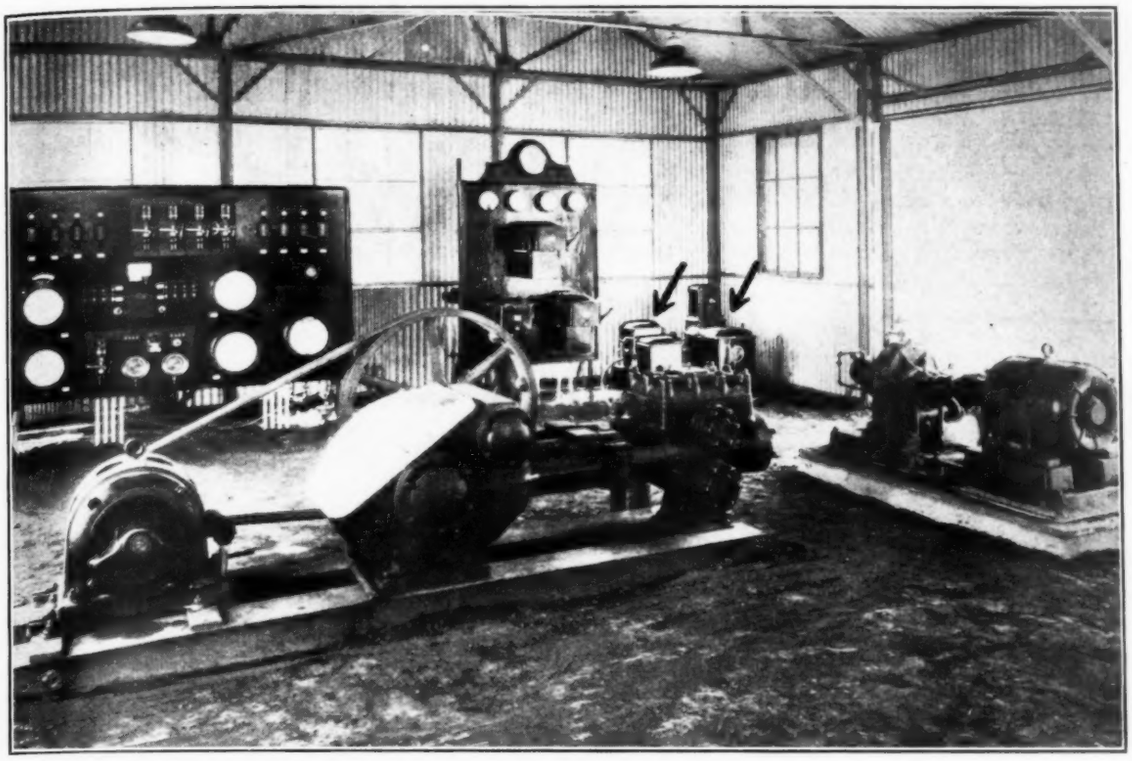




Above, Figure 9—Smaller size cam pumping unit in operation in the Summerland Field (Deep Zone), California. Geo. F. Getty, Inc., operator.

At left, Figure 8—Smaller size cam pumping unit in operation on the Frenger lease of the Shell Oil Company, Torrance field, California.

[9] The computations were based on Stokes' Law as given in "Mathematical and Physical Papers," Sir George Stokes, Vol. III, p. 55, et seq., and "A Textbook of Physics," by J. H. Poynting, p. 222, et seq., supplemented by a study of "Fluid Resistance to Moving Spheres," by R. G. Lunnon, in the Proceedings of the Royal Society of London, 1928, Vol. 118, Series A, p. 118, et seq. The necessary constants were derived from actual test data.



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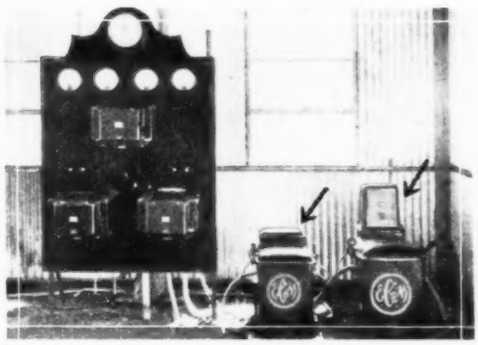

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weight of two and one-half feet per pound was used. Figure 7 shows the necessity for maintaining pressure losses at a minimum for low fluid levels in order to avoid gas lock.

The constant-velocity cycle pumping unit described in this paper is made in two sizes. Figures 8 and 9 show the smaller size cam pumping unit, which very closely follows the design of the original experimental unit. It is primarily for slow-speed work, but some operators are using this unit satisfactorily at speeds up to 14 strokes per minute. Figure 8 shows the motor and drive and Figure 9 shows the cam and followers. It will be noted from these two illustrations that the well can be pumped from either end of the beam, at the option of the operator. The electrically-welded steel frame provides maximum strength with minimum weight.

Figure 10—Larger size cam pumping unit in operation on the Thompson lease of the Standard Oil Company in the Huntington Beach field of California.

Figure 10 shows the larger size cam pumping unit. This unit has exactly the same constant-velocity cycle as the smaller model, but is totally enclosed and self-oiling. It uses a double cam drive which provides smooth action even at high speeds. This is an exceptionally sturdy unit for pumping deep wells up to 500 barrels daily. The writer has no test data on the operation of this larger unit for deep wells at the higher pumping speeds, but at these higher plunger velocities turbulent flow occurs through the standing valve, which would create a substantial advantage in the constant-velocity cycle over the crank-pin cycle on such wells. (Refer to Footnote 6.)

In conclusion, a few practical pointers will be given on the application of slow-speed pumping, gleaned from our experience on this work during the past five years.

In general, critical pumping speeds must be determined within closer limits on small wells than on large ones. A difference of two-tenths stroke per minute on a well operating at three strokes per minute will make a substantial difference in production. For this reason the pumping equipment used should have a flexible drive, providing changes in pumping speeds quickly and easily in the field. The multiple V-belt drive as used on the cam pumping units admirably fulfills this requirement, as the pulley ratios on this type drive provide unlimited speed variation, and pulley changes are readily made. However, where a number of units are to be installed it will be found extremely advantageous to equip a test unit with a variable speed drive as used on the experimental unit described in this paper.

This test unit can be readily moved from well to well for determining critical speeds and studying any pumping problems which may arise.

In choosing the size of pump to use, the Pressure Loss Chart, Figure 6, should be used to keep the pressure loss as low as is consistent with the minimum critical plunger speeds. On the more viscous oils, 2½-inch and 3-inch pumps are necessary. As a rule, the tubing should be the same size as the pump; that is, a 2-inch pump should not be used on 2½-inch tubing or a 2½-inch pump on 3-inch tubing, as the fluid velocity in the tubing is then so low that sand or sediment in the oil is not carried out but settles down around the traveling valve. A fairly long stroke should be used, preferably 36-inch, as this gives a greater time interval on the down-stroke for putting expanded gas back into solution.

On wells operating below two strokes per minute, and in heavy, viscous oils it is sometimes necessary to use a friction garbutt rod or similar device to effect a positive closing action on the standing valve at the beginning of the down-stroke. In the friction garbutt rod a couple of pieces of spring steel are welded to the top of the garbutt rod, engaging a friction grip on the inside of the plunger. The box of the standing valve is bored out and the lower end of the garbutt rod is run through the box into the standing valve cage, and a lock-nut placed on the end of the rod to hold it in the cage on the up-stroke. This device forces the ball into the seat at the beginning of the down-stroke, and if the friction grip is not too strong it will not pull the standing valve on the up-stroke. Positive action valve attachments for both standing valve and traveling valve have been used successfully in California and give a positive opening and closing valve action. Major advantages of slow-speed pumping:

1. Volumetric efficiencies of 90 per cent or more are usually secured, and in one case this high efficiency was obtained with a 2-inch pump operating at only seven-tenths of a stroke per minute (36 inches) from a depth of 2200 feet. A constant-velocity cycle unit was used.

2. With the use of constant-velocity cycles, production increases of 300 per cent are not unusual and a 50 to 100 per cent increase is common.

3. Substantial reductions in lifting costs are always secured, due to the lesser power costs, reduced wear and tear on equipment and less well pulling and cleaning out. In one case a well which had been averaging three and one-half crew jobs per month, and direct costs for labor, material and power of $153 per month, operating at high speed with a volumetric efficiency of less than ten per cent, was equipped with a slow-speed constant-velocity cycle unit and operated eleven months without the slightest attention. The total direct costs were $4.80 per month and the volumetric efficiency was 90 per cent, with increased production.

The Delayed System *of* Drilling, *in the* Water Flooding *of* Oil Sands

By PAUL D. TORREY, *Consulting Petroleum Engineer*

THE application of the delayed system of drilling wells in the intensive water flooding operations of the Bradford and Alleghany fields came as a logical improvement to the methods previously employed in this area for increasing the recovery of oil. The utilization of this method was originally planned as a means for controlling a definitely known and very troublesome sand condition, but subsequently it has been most advantageously applied under practically every known condition. The results obtained so far have indicated that delayed drilling will materially increase the effectiveness of water-flooding operations. Delayed drilling has been accepted not only because of its acknowledged efficiency, but also owing to the ease and absolute control under which delayed floods may be operated when proration schedules of production are required. The development of delayed drilling has been most opportune in that it has provided a means of production control that reduces operating expenses in a partial proportion to a curtailed yield and at the same time does endanger the possibilities of obtaining the anticipated ultimate recovery from a flood which might never be realized under ordinary methods of operation. In addition, the flexibility of its application and the ease with which it may be modified to meet the most varied conditions, has appealed to many progressive operators, particularly in the Alleghany field, as a happy solution to certain of their operating problems during the past months when conditions of general economic depressions have required a restriction in output.

Typical water plant in the Bradford (Pa.) field.

The development of water-flooding methods has been rapid. Each improvement in operating technology has been introduced either as a means for increasing the efficiency of the flood or to accelerate the recovery of oil, in order to maintain a better balance between what has been an almost ever-increasing valuation of properties and the rate of return from the investments in land and development. It can be readily appreciated that the rejuvenation of depleted or partially depleted oil fields is not associated with the hazards so intimately connected with the oil business in general, for in most cases the area of the field is defined, its comparative quality has been established in relation to other fields from an analysis of initial productions and ultimate recoveries, and in modern operations the character of the sand and its oil content has been pre-determined from core studies of the reservoir rock before any actual development work is started. It is, therefore, possible for an operator closely to estimate not only land, development and operating expenses, but also to know in advance, within reasonable limits of error, what recovery he may expect. From an engineering standpoint he can obtain a complete answer and the only variable which he cannot accurately predict, and upon which his rate of return is to a large measure based, is the question of price. This, of course, is an economic problem and is beyond the scope of purely engineering investigation, but in order to assure an adequate return upon the large investments involved in water-flooding operations when production is reduced by pro-ration or when land valuations are increased, the engineer is confronted with the problem of either reducing operation expenses or increasing oil recovery.

Although there has been great improvement in operating efficiency during the past five years, there are certain limits beyond which costs may not be safely reduced. These limits cannot be exactly defined, but it is obvious that if the production of a flood producing, say, 200 barrels a day, is reduced one-half by pro-ration schedules, approximately the same number of men will be required to operate water-pumping plants, pumping powers and to pull wells. Therefore, operating costs, under ordinary conditions, cannot be reduced in direct proportion to a curtailed production. Since land and development costs are rather definitely fixed items, the only alternative is to increase oil recovery; that is, produce more oil per acre to meet the decreasing return of capital accompanying a depressed oil market.

It is almost needless to describe in detail the changes that have taken place in the technology of water flooding

during the past ten years. The gradual evolution of flooding methods from the old unsystematic and in many instances accidental circle floods to the line floods and then to the intensive floods in operation at the present time, presents a history of constantly increasing efficiency which has been culminated by the successful application of delayed drilling as a means for further increasing the recovery of oil. The actual mechanics of water-flooding action in an oil sand cannot be positively stated, since no one has had an opportunity actually to observe flood movement through a reservoir rock. The study of records of water input and of oil and water production from the producing wells, combined with the analyses of cores from oil-bearing strata, both from areas unaffected by water and from partially and entirely watered out areas, have been responsible for certain conclusions, which, of course, may not be correct, but which certainly cannot be questioned in the light of our present information. Water-flooding has only been successful in sands possessing pore-spaces of capillary size, so it may be reasonably assumed that capillary action is an important factor in the displacement of the oil held in the interstices of the sand and adhering as a film on the sand grains. However, it seems probable that capillary effect acts only as a displacing agent and that the motivating force which accumulates the oil and pushes it toward the producing well is supplied by the encroaching water under pressure from the input wells, and from the expansion of gas held in the pore spaces unoccupied by oil and dissolved in the oil. However, it is rather doubtful whether the effect of expanding gas is very material in ordinary flooding operations, since practically all of the free gas in the pore spaces must be depleted before the peak of oil production is reached. Such gas as may be derived subsequently escapes by evaporation from the oil in the area immediately surrounding the producing oil well where there is the greatest relief of pressure. Water-flooding, as it is generally practiced at the present time, therefore, consists of a capillary displacement from the minute pore spaces of the sand and a subsequent movement under what is essentially hydraulic control with probably little assistance from the powerful propulsive effects of expanding gas.

Pumping well in the Bradford field.

The analyses of hundreds of cores of the Bradford and Richburg sands, from areas unaffected by water and from areas in which water floods are in all stages of depletion, has clearly shown that past water-flooding operations, even in areas underlain by apparently homogeneous and uniform sand bodies, have been really inefficient, in that it has been found that in no instance has the entire sand body been effectively depleted; that is, the oil content reduced to a saturation of from 15 to 20 per cent. In every case it has been found that the flood has been moving more rapidly in the lenses of sand possessing the highest permeability, leaving the lenses of lower permeability either entirely unaffected, filled to a maximum saturation with concentrated oil, or partially depleted. Such irregularities are more noticeable where the sand possesses great variations in permeability or where conditions of extreme lenticularity of individual beds exist but even in reasonably uniform sand, cores have shown that only about 50 per cent of the sand body has been watered out to the limits of flooding depletion.

The reason for such conditions seems to be obvious in as much as there is a constant relief of pressure at the producing oil well. The water on entering the sand body naturally moves with greater rapidity through the lenses possessing the highest permeability and establishes channels of fluid movement, the resistance of which decreases as the oil is removed. Since a constant hydraulic head is maintained at the input well the beds of lower permeability will take a fixed amount of water which undoubtedly is very small or practically negligible in comparison to the amounts going into the more permeable beds. In the event that sufficient pressure should be applied at the input well to force flooding action in the tight parts of the sand, such large volumes of water would rush through the more open parts of the sand that the handling of the fluid, which would chiefly be water, at the producing well would be economically impossible. In addition, since the pressure is being constantly relieved at the producing well by systematic pumping, it is questionable whether the pressure can be increased in the tighter parts of the sand to the point where effective flooding action will take place. It is easily conceivable that a water pressure sufficient to cause fluid movement through the tighter parts of the sand and at the same time supply the requirements of the beds of high permeability, might readily break through the thin micaceous and argillaceous filament separating the individual beds of the sandstone allowing the water to move along pre-established channels.

The delayed drilling of oil wells in a five-spot flood was first tried as an experiment on a property in the Alleghany field where previous flooding operations had not yielded

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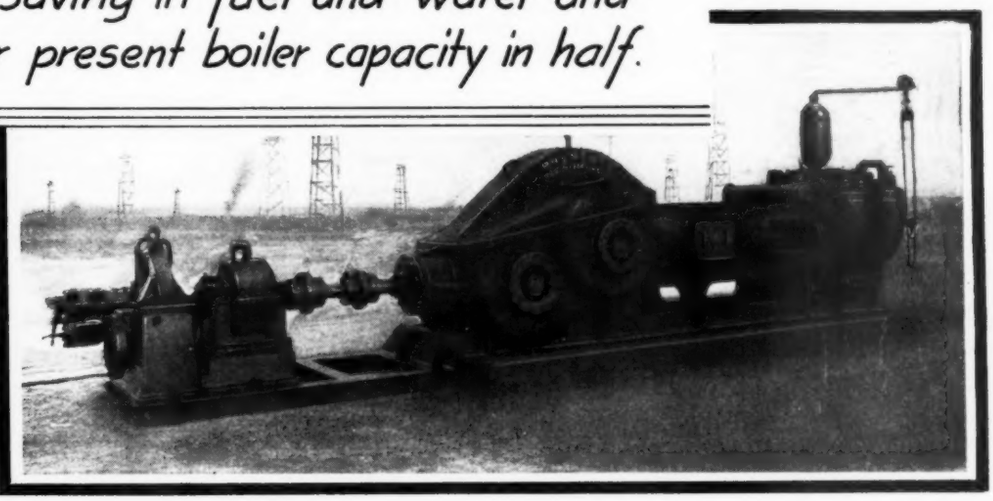

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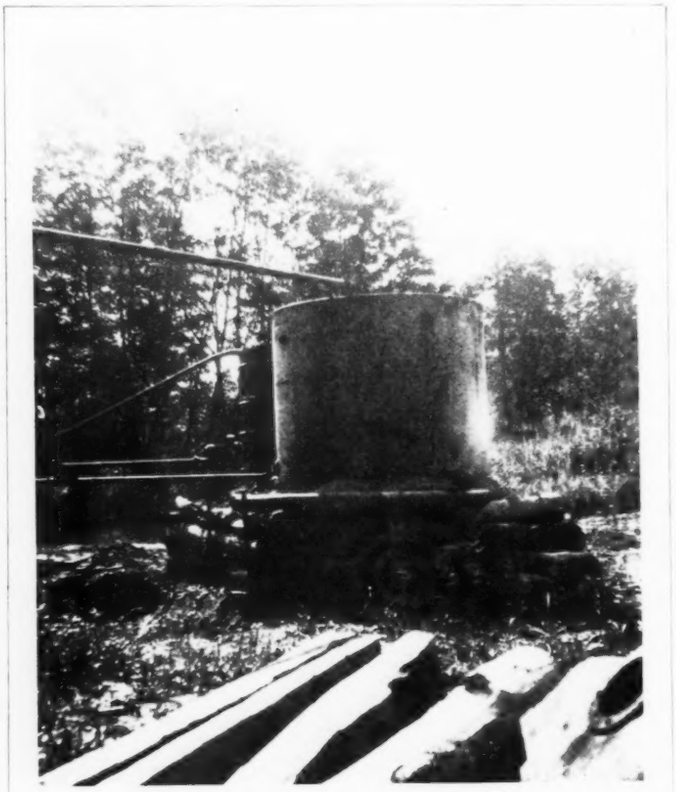
satisfactory results and where cores had shown that the beds of the sand body possessed wide variations in permeability, although an average oil content was available. After the cores had been studied it could be easily appreciated why the floods had not been successful: the water was obviously moving through the beds possessing a high permeability, leaving the rest of the sand unaffected.

The underlying principle of delayed drilling is very simple. By delaying the drilling of the oil well in the five-spot square a uniform concentration of oil is forced into the center of the square through each bed. Each individual bed of the sand-body possesses a definite and fixed capacity to hold fluid and when this capacity of the high permeability beds is reached the pressure can be raised to the point where effective flooding action takes place in the tighter parts of the sand without any detrimental effects to the rest of the sand-body. After the sand-body, within the five-spot square, is completely saturated with fluid, which may be determined by the fact that the input wells will take no more water, the oil well is drilled.



Tank battery used at Bradford.

The results from this first experiment have been most gratifying and are shown in Table No. 1. Delayed drilling has already produced in less time over three times as much oil as ordinary flooding operations.

Following the success of this first delayed flood several other delayed floods were started in the Alleghany field. Accurate data are not available on certain of these and others have been held back owing to proration restrictions so that the information that can be obtained from the records of production is not exactly conclusive. However, it may be stated that so far as the writer knows, these floods have proven, up to the present time, to be eminently satisfactory. The records of two floods located in what is known to be excellent territory with homogeneous sand bodies are available and are presented in Table No. 2. In property No. 1 comparative data are from an adjoining property, but on property No. 2 the comparison has been made from floods in operation on it.

On both of these properties adequate pressure has been available although on property No. 2 the pressure has been increased very gradually. The ultimate production of both the delayed five-spot floods and the ordinary five-spot floods has been estimated by the extrapolation of decline curves and based upon past operating experience should be accurate within 200 barrels. It, therefore, seems probable that delayed drilling will increase the ultimate recovery on these properties approximately 20 per cent.

The reason for this indicated increase in oil recovery may be attributed not only to the enforced uniformity of flooding action which accompanies delayed drilling, but also to the assistance of expanding gas in the oil. In ordinary flooding action the area of sand affected by water, as first pointed out by Herold,[1] is of an elliptical shape, the length of the short diameter of the ellipse being in proportion to the pressure applied at the input well. However, since there is a constant relief of pressure at the producing well, it is very unlikely that the four ellipsii extending from each water well to the central oil well ever overlap to any great extent. There is, then, an area between each two intake wells that is little affected by the water. In delayed drilling this condition cannot exist for as the sand reaches the point of relatively complete saturation the pressure applied at the intake wells is transmitted undiminished throughout the entire sand body instead of through a restricted area. Since there is relatively very little motion of fluid in the sand body within the five-spot square, when the point of saturation is reached, there can be practically no loss in pressure owing to frictional resistance to fluid movement. In addition, all gas occupying pore spaces unfilled with oil is forced into solution in the oil, so that when the producing well is drilled there is a movement of oil from all directions rather than from just four local points, accelerated by the powerful propulsive effect of expanding gas pushing against a solid bank of oil and followed by encroaching water under pressure. The conditions brought about by delayed drilling therefore very closely resemble the original conditions existing in an undepleted reservoir of oil. Since the oil is concentrated toward the center of the five-spot square in each bed, and the pressure applied at the intake well uniformly affects the oil in each bed, the amount produced from each one is a function of its oil content rather than the results of differential flooding action in a sand possessing lenses of varying permeability. Therefore, when the oil well is drilled there is a rush of oil into the hole from each bed possessing a permeability sufficiently high to allow for fluid movement, rather than a flooding action at different rates of speed in each individual case, which, as has been previously shown, results in very inefficient flooding results.

The development of delayed floods presents no great operating problem. All old holes must be plugged in order to prevent any relief of pressure while the sand is being saturated. It is also desirable to arrange for a delay in the drilling of offset wells if the flood is located along a property line. It is almost essential that a uniform and equal volume of water is pumped into each intake well in order that the oil may not be concentrated off-center. It is most desirable to understand as fully as possible the conditions existing in the sand body in order to know in advance what pressures will be required and to be able to estimate how long a delay is necessary. Such informa-

[1] Herold, Stanley C., "Some Analytical Principles Concerning Oil Recovery by Forced Drive," A. I. M. E., Pamphlet 1607-G (1926).

The clean drilled hole is the straightest!

Drilling straight hole is dependent upon many factors. The most important of these is the drilling bit which must be of the best materials and of correct design. It is what occurs at the bottom of the hole rather than what occurs at the top which determines in most cases whether a hole is straight or crooked.

The Alco Type X Bit, machined from the highest grade of alloy steel, heat treated in electrically controlled furnaces, and hard-faced with stellite, assures the operator extra durability. Perfect balance and lessened torque on the bit shank are the result of years of design experience.

Five circulation outlets have been provided in the Type X Bit which give maximum washing action over the cutting edges. The center hole plays a wash directly on the pilot blades, while the remaining holes circulate fluid which keeps the cutter blades from balling up or heating.

Alco Bits drill faster, cleaner, straighter, and longer because they are structurally right.

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TYPE X BIT

Alco Type X Bit mounted on regular bit shank illustrated on left. Above are shown the five circulation holes used in the bit face. This bit drilled over 2000 feet of eight inch hole before renewal

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tion can only be obtained from core studies. Since delayed wells ordinarily flow, pumping may never be required, for when the oil is removed its place is occupied by water and a condition of hydraulic balance is maintained between the intake wells and the producing well. Under pro-ration schedules the amount of oil required may be flowed and the well then shut in until the next day. It is also of interest to note that delayed floods need not be drilled as soon as the sand is saturated, if market conditions are not favorable. As long as pressure is maintained at the intake wells the time of drilling of the oil well may be almost indefinitely prolonged without any apparent harmful effects. The drilling of delayed wells has been extended eight months, after the sand was saturated with fluid, without any noticeable effect upon initial production or normal decline. The production of delayed wells very closely corresponds to the decline curves of natural production from wells in a new field. The largest initial production yet attained by delayed drilling is 118 barrels a day.

In conclusion it is only fair to state that the best results from delayed drilling will be obtained in areas that possess sands of varying permeability. It would be unreasonable to expect that a delayed flood would show an equal increase in recovery in both uniform and variable sand bodies. The results from floods now in operation indicate that delayed drilling may be most advantageously applied to uniform sands for reasons previously described. Although none of the delayed floods in uniform sands have reached the limits of economic production, their present status and past production indicates that an increase in recovery of 20 per cent may be reasonably anticipated.

TABLE NO. 1.

Comparative Results of Delayed Five-Spot and Ordinary Five-Spot Floods.

Ordinary 5-Spot	26	1.43	1,848.35*	1,292.4*	8,534.0*	5,968*
Delayed 5-Spot	22	2.06	8,298.5	4,002.8	10,104.0	4,904

*Ultimate recovery.

TABLE NO. 2.

Comparative Results of Delayed Five-Spot and Ordinary Five-Spot Floods in Areas Possessing Homogeneous and Uniform Sand Bodies.

First Property:				
Ordinary 5-Spot	28	5,150	6,500	No Record
Delayed 5-Spot	13	4,080	7,750	340
Second Property:				
Ordinary 5-Spot	21	4,672	7,000	6,150
Delayed 5-Spot	10	3,981	8,800	None

Aluminum Bulk Haul Train

THE Three D's Products Distributors, Inc., at Fort Worth, Texas, operates the largest aluminum bulk train in the state. It is used to transport gasoline from the Waggoner Refinery at Electra, Texas, to the bulk plant in Fort Worth.

The company has found that the use of aluminum tanks has reduced the cost of transportation due to the lower weight per gallon of gasoline carried. The train consists of a semi-trailer and a six-wheel trailer. The former has a capacity of 3,325 gallons and weighs 3,800 pounds, and the trailer has a capacity of 2,875 gallons and weighs 3,320 pounds. The weights mounted are 5,970 pounds for the semi-trailer, 9,800 pounds for the six-wheel trailer. A Mack B J truck weighing 10,400 pounds hauls the train.

Specifications

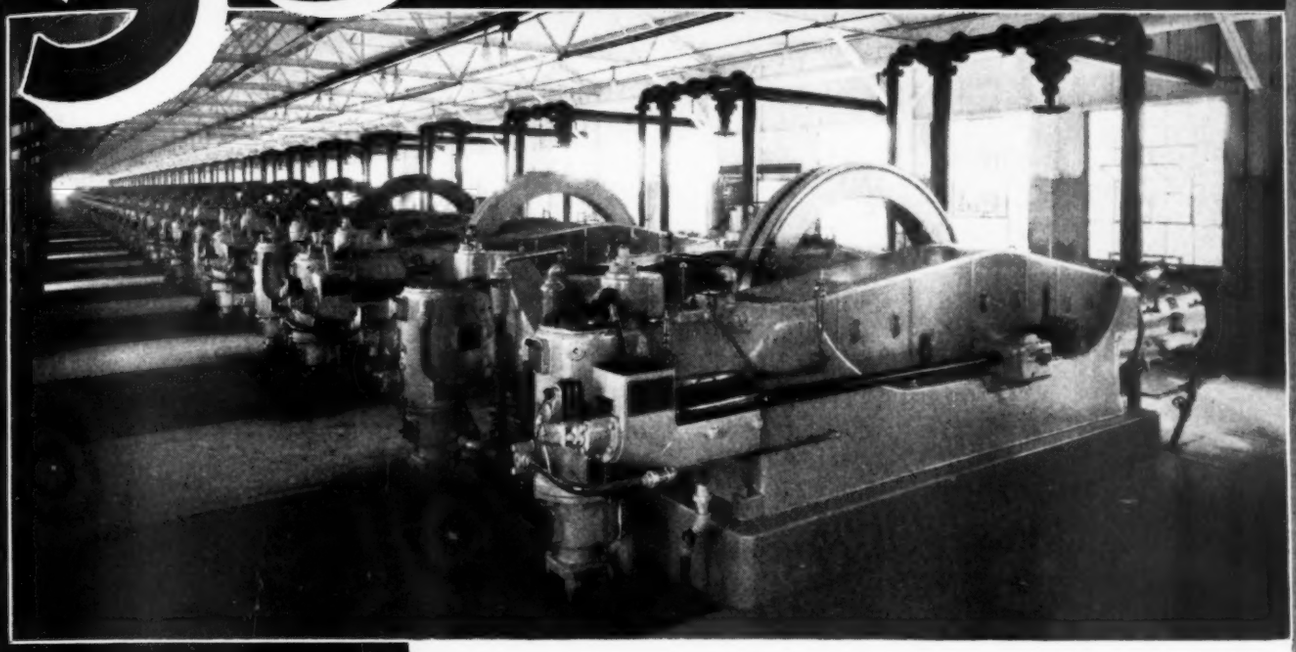
1—3,325-gallon, 4-wheel semi-trailer, drop frame aluminum tank, 3-compartment, 3-inch piping, hydraulic emergency valves, steel mounting, full skirting and fenders. Weight tank complete, 3,800 pounds. Weight per gallon, 1.143 pounds.

1—2,873-gallon, 6-wheel drop frame aluminum trailer tank, 3-compartment, 3-inch piping, hydraulic emergency valves, steel mounting, full skirting and fenders. Weight tank complete, 3,200 pounds. Weight per gallon, 1.113 gallons.

The low weight per gallon is characteristic for aluminum tanks.

Aluminum bulk train at Fort Worth, Texas.

36 STEADY PERFORMERS



YOU'RE ALWAYS SAFE IN CHOOSING A TYPE-80 COOPER-BESSEMER

EVERY ONE THE PRODUCT OF THOROUGH ENGINEERING

HERE'S another company which agrees that Cooper-Bessemer Type-80 compressor units are without equal in their class. The photograph shows 36 of these four-cycle gas engine driven compressor units after they had been in service for about four years in Plant No. 13 of the Sinclair Oil and Gas Company, located in the Seminole field. (Some of these engines have recently been moved to other plants.)

THE COOPER-BESSEMER CORPORATION

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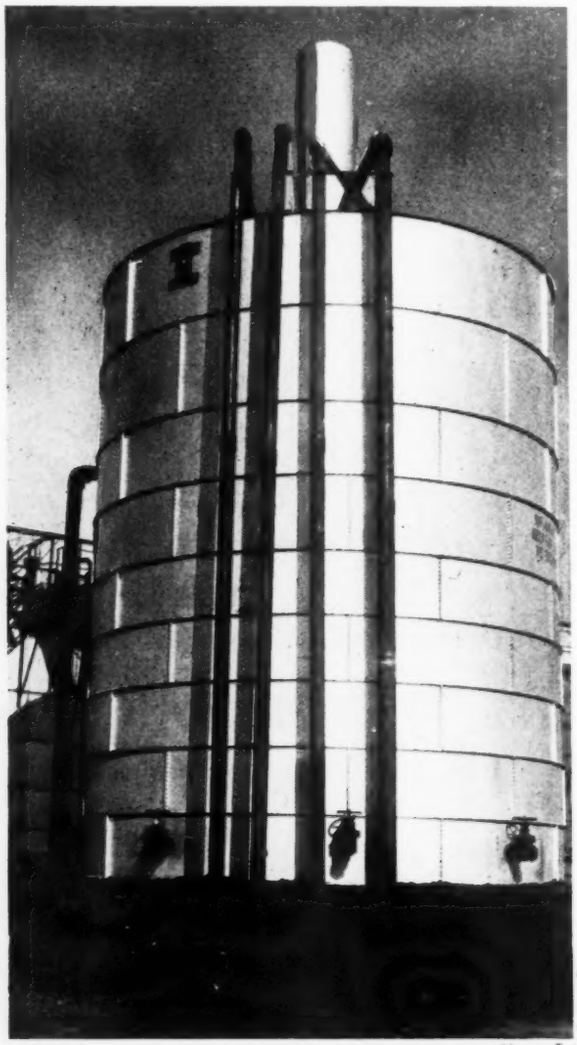
High Pressure Sand Cutting Well

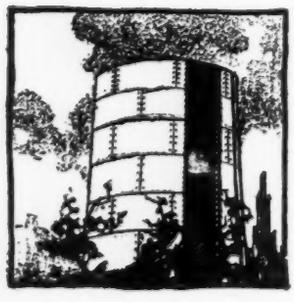
THE latest attempt of operators in the Oklahoma City field to control the well flow during the period of completion, and especially to govern the destructive sand-cutting of these big producers, consists of a new type hook-up of separators. The main features of this new set-up are large outlet flow lines, which offer little friction to the pressure and passage of fluid, and a new separator into which all of the fluid—rotary mud, sand, gas and oil—is flowed and separated.

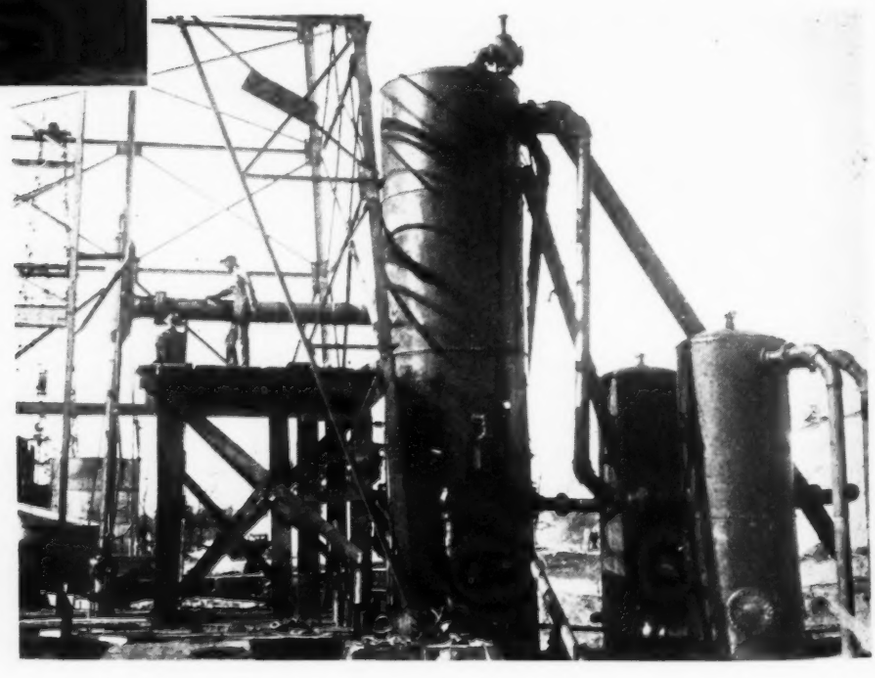


This hook-up was used for the first time by the Phillips Petroleum Company on two of its wells which are within the congested zone of the city limits. The location of these wells, surrounded by houses and other adjacent properties, made it extremely important that the flow be controlled so that damage and danger to life and property would not be incurred. Roden No. 1 came in with an output of approximately 76,000 barrels per day, with 57,000,000 cubic feet of gas, and was successfully handled by the new hook-up and had 45 pounds pressure on the separator. It made 500 barrels of sand. King No. 1, with 65 pounds pressure on the separator, flowed 5410 barrels in two hours and thirty minutes.

The installation as used by the Phillips Company included one large separator with two smaller ones set to the rear, and connected by a series of flow lines in which right-angle bends were eliminated and a flow head set over the Christmas tree connections.

The flow was directed from this flow head through a 12-inch line to the large separator, entering on the side at a point near the center. In this separator the gas, oil, mud and sand were separated. The large separator is seven feet in diameter by 29.3 feet high, weighing 24,000 pounds, while the smaller ones used were five feet by sixteen feet. The oil and gas as it was separated came out of the top of the large separator, the former going to the tanks, with the gas passing into the smaller separators for more complete scrubbing. The mud and sand came out of the separator at the bottom. The mud goes through a 10-inch





Above—The sand settling tank, showing flow lines and outlet valves at bottom. At right—The entire separator installation.

Utilizes a New Separator Hook-Up

line to the slush pit, while the sand is periodically emptied from the separator through a sand line to the sand settling tank.

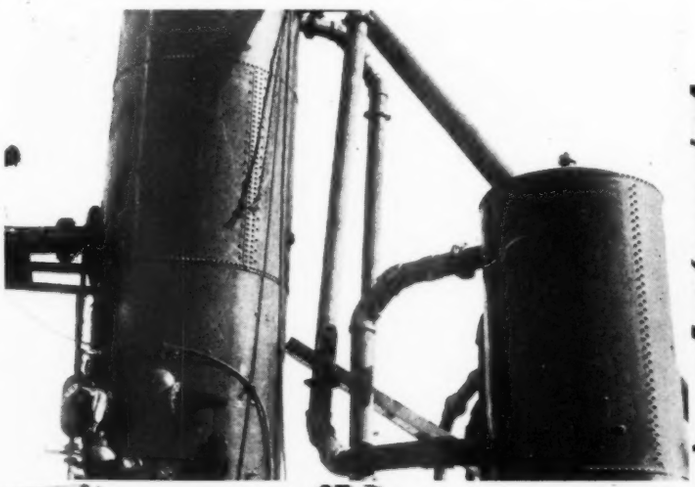
The three separators were connected by a series of lines, consisting of one 12-inch pipe sloping downward from the back side near the top of the large separator to a point in the rear of the two smaller ones. At this point eight-inch lines carried the flow into each of the small separators. Two other lines of eight-inch diameter pipe were connected from the large separator directly to the smaller ones.

The smaller separators were primarily for further scrubbing out of the gas, but also acted as an additional safety factor. If the large separator should become full of sand, before the gate was opened for its removal the flow lines would carry the oil and gas over into the smaller separators, thus relieving the pressure. The small separators also segregated the fine sand particles carried from the big trap with the gas, thereby eliminating them from further passage through the lines.

Equipping this installation with a sand line to the sand settling tank was for the purpose of saving all of the oil which was mixed with the sand. The sand settling tank was equipped with valves at a number of points to permit cleaning out the sand. In the city limits, keeping properties clean is quite an important item, and by the method described the sand blown out of the hole could be loaded onto trucks from the tank and hauled away.

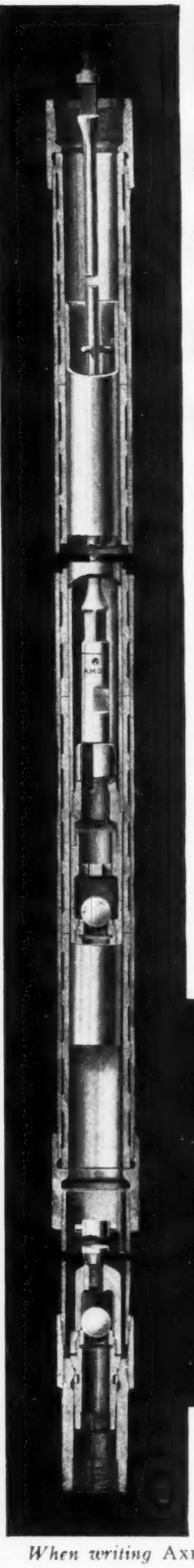
Every possible effort was made to take care of the flow. No gates were used from the Christmas tree to the separators. This, together with the large and plentiful supply of flow lines, assured a free open flow at all times. During the period of completion of the Roden well the flow was handled with ease. An additional safety factor installed was the equipping of the big separator with a large relief valve to handle any troublesome pressure.

Another feature of the hook-up was the ability to remove part of the separator set-up after the period of completion, when the flow of sand is naturally greater than after it has settled. Engineers of the Phillips Petroleum Company plan to remove either one or two of the separators, depending upon the conditions found during the period of completing. If a heavy sand flow was encountered it was planned to leave the large separator and remove the two smaller ones, or if little sand was present the big separator was to be removed and either both or only one of the smaller ones left, depending upon the size of the well. This would permit the use of the separators during the period of completing at other wells.



At left, above—A side view of the hook-up. At left—Rear view of the separator hook-up. Directly above — Connecting up the flow line from the sand cushion.

THERE IS NO ECONOMICAL SUBSTITUTE FOR QUALITY



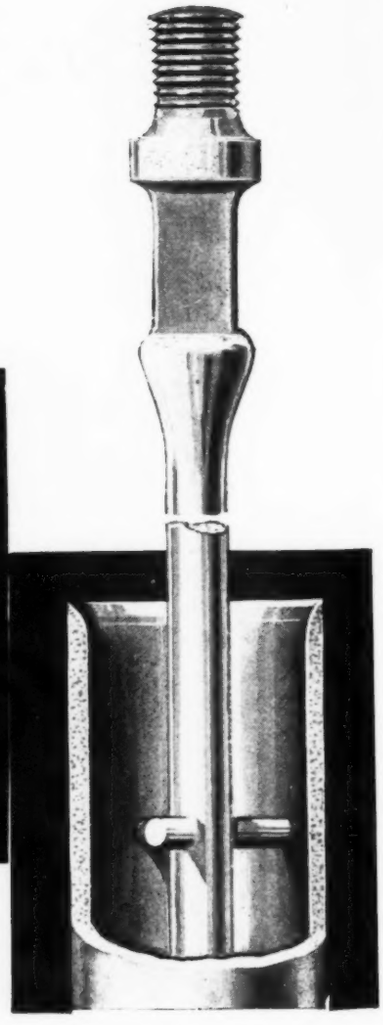
Handles sand without sacrifice of fluid Volume

Total fluid volume is the determining factor in pumping oil wells and the Axelson Barnwell Plunger not only handles large quantities of sand but handles it without lowering production of the well.

Valves are close together and for this reason gas troubles are eliminated. The top of the Barnwell Plunger is open, allowing free passage of oil into the fluid column. There are no production congestions, for the fluid carries the sand free and the wells are kept clean.

The construction of the plunger is such that a slight expansion is possible on the up stroke which keeps the liners clean of sand while on the down stroke the frictional resistance is decreased.

These are the salient features. Let our representatives tell you about this plunger in detail.



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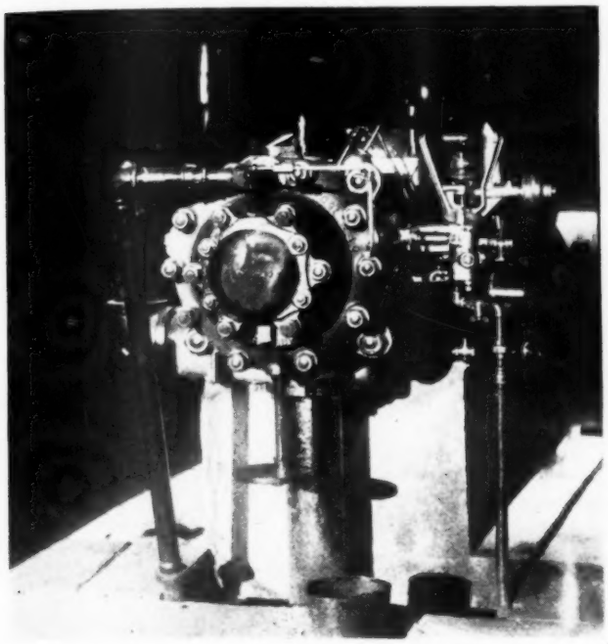
Slow-Speed Oil Engines » » *on* Pumping Wells

ENGINES for oil well pumping service have been improved in design and construction in recent years because of the stringent duty requirements they must fill under present-day competitive production practice. In this respect the slow-speed oil engine has kept pace with the demands made upon it. In the Lost Lake field in the Gulf Coast, four 50-H. P. slow-speed oil engines are pumping eight wells. Each engine pumps two wells. One well, the heavier, is pumped in the ordinary way on the beam, with the power transmitted by belt from the engine to the bandwheel. The power to the other well is transmitted through pull rods to a pumping jack.



One of the 50-H. P. oil engines, with which the J. S. Abercrombie Co. wells in the Darst Creek field are equipped.

Operating problems in this field are peculiar to the Gulf Coastal region in which the field is situated. All material has to be shipped about four and one-half miles by water to the field. This relative inaccessibility makes it imperative that all equipment used can be operated continuously over long periods with a minimum of trouble. Aside from inaccessibility, the supply of gas from the field is somewhat limited, and water, though plentiful, is not the most desirable for use, when considering prime movers, without some kind of treatment. By installing oil engines for pumping wells in this field, the fuel problem was disposed of and the problem of water supply did not enter; at least, to any important extent.

The eight wells combined have a total daily fluid production of approximately 1,000 barrels. Of this amount 400 barrels is oil and the remainder water. The average depth of the eight wells is approximately 2,800 feet and all are pumped from this depth.

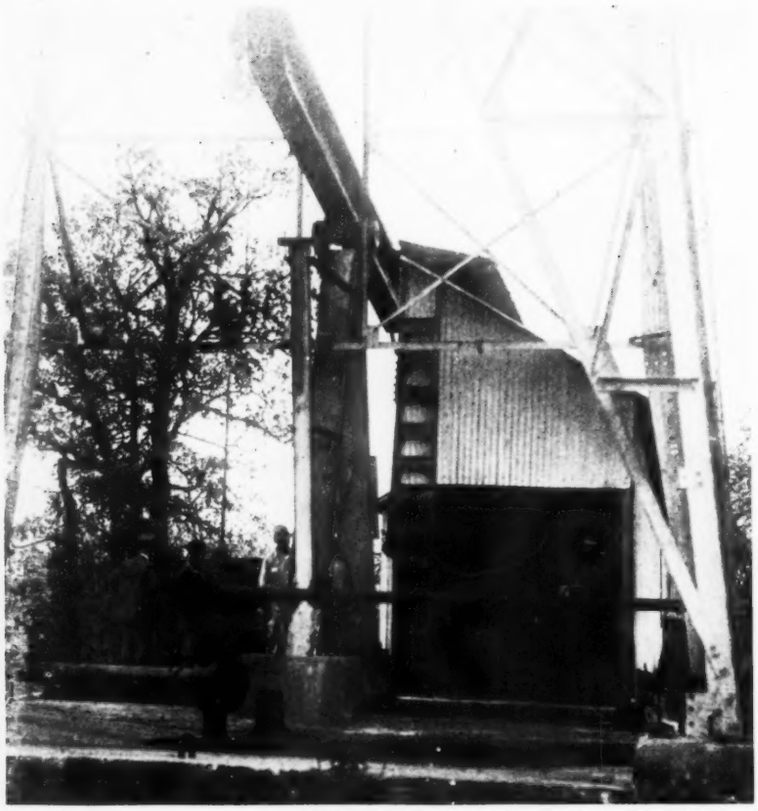
On the beam pumping wells the power transmission consists of a 16-inch diameter engine pulley, 26-inch face, a 12-foot steel bandwheel, 24-inch face and a 22-inch belt. Every well has been carefully counterbalanced and a smooth, uniform pumping motion is obtained. One important contributing factor to the smooth running is the use of 22-inch belts. These transmit the power with a minimum of slippage. An average speed of 20 strokes per minute is maintained on all wells. The engine speed at this pumping rate is 180 r. p. m.

Crude oil produced by the wells—about 22 degrees A. P. I.—is used in the engines for fuel. All oil produced has to be treated before shipment. Before it is used as fuel in the oil engines it is run through a filter composed of about 26 thicknesses of cheese cloth as a precautionary measure to remove any trace of water or sediment that may be present.

Although the fuel is of a fairly heavy grade, no trouble has been experienced at the engine. Fuel consumption averages about 17 gallons per day per well. It was already stated that the total fluid from the eight wells averages about 1,000 barrels a day; 400 of oil, and 600 of water. This gives an average of 125 barrels per day per well.

Based on a crude price of $1.00 per barrel, the fuel costs,

Wells on the Thomas Dix lease of the J. S. Abercrombie Co., Darst Creek, Texas. Pumped by oil engine.



Well of the J. S. Abercrombie Co. in the Darst Creek field pumped by oil engine. Engine runs at about 160 r. p. m., giving about 20 strokes per minute at the polish rod.

using the foregoing figures, are as follows:

40½ cents/day/engine	.41 cents/bbl. oil lifted
20¼ cents/day/well	.16 cents/bbl. fluid lifted

In the Darst Creek field in Texas, oil engines are employed by the J. S. Abercrombie Company on all their pumping wells. Four wells are equipped with 50-H. P. engines and one has an 80-H. P. engine. The 80-H. P. engine, on well Thomas Dix No. 4, besides pumping the well, supplies power to a 5⅞-inch by 12-inch duplex power pump used for pumping oil from the lease to the tank farm, and a smaller auxiliary pump for tank bottoms and other miscellaneous pumping on the lease.

All five wells are pumped on the beam. A standard set-up has been used at the wells and except for slight variations in pulley ratios all are equipped alike. In the power transmission system a countershaft drive with 27-inch or 28-inch pulleys is used. The engine pulley is 40-inches diameter and the bandwheel 12 feet. The latter is of steel. Belts used are 14 inches in width. Between the engine pulley and countershaft and between the countershaft and bandwheel, the centers are 19 feet and 32 feet, respectively.

Wells are pumped from a depth of approximately 2,580 feet through 3-inch external upset tubing. An average pumping speed of 19 to 20 strokes per minute is usually maintained when the wells are pumping. This gives an average engine speed of 175 r. p. m. Proration of production in the field has changed the regular pumping schedule.

During the time the oil engines have been in service in this field they have given no trouble. Ease of starting is one characteristic of the engine that is appreciated by the field men. Any oil engine on the lease can be started in 2½ to 3 minutes by one man. This fact, together with the absence of trouble, appeals to the pumper and the field men.

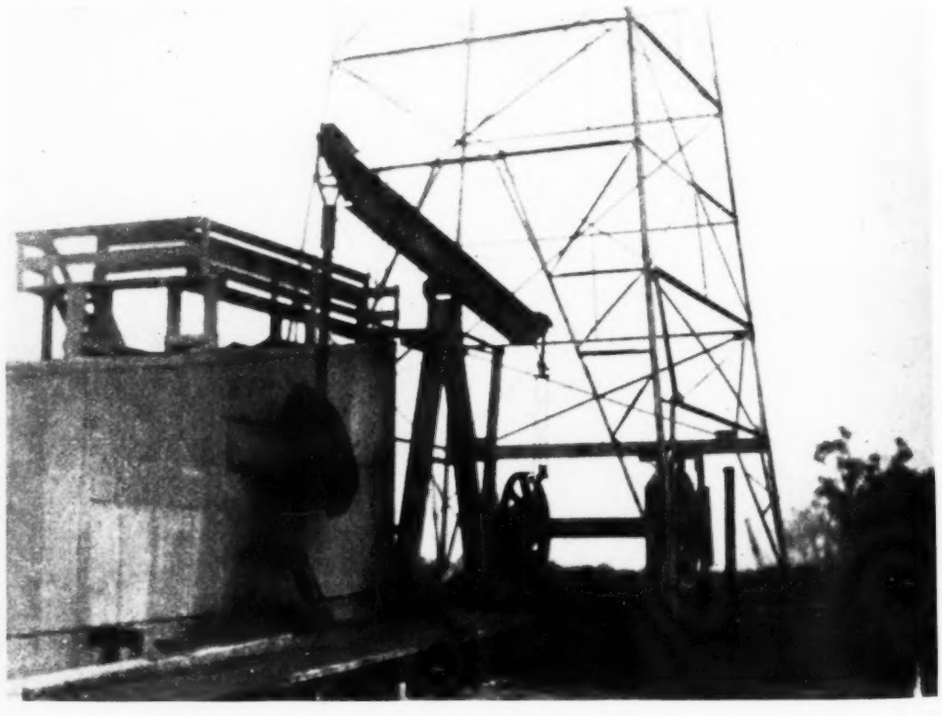
Fuel for the engines is taken right out of the lease stock tanks and used in the engine without any treatment. The gravity of the oil is 38 degrees A. P. I.

Available information shows that the five wells have pumped on the beam a total of approximately 5,200 barrels of fluid daily from an average depth of approximately 2,580 feet. Of this amount of fluid 1,785 barrels was oil. This is about 1,040 barrels fluid daily per well of which about 350 barrels is oil.

The average fuel consumption when pumping at this rate is 40 gallons per engine per day. Assuming a price of 90 cents per barrel, the fuel costs, using the foregoing pumping schedude, are as follows:

86	cents/day/engine
.25	cents/bbl. oil lifted
.082	cents/bbl. fluid lifted

Where the cost of fuel is high or where fuel is a problem, the oil engine for pumping wells is claiming increased attention from engineers and field men. The performance of those oil engines now in use in the field, especially those employed in oil well pumping service, is being closely watched by field men everywhere.



Pure Oil Co. well in the Lost Lake field—pumped by 50-H. P. oil engine.

Control Instruments *for* » » *the* Natural Gas Industry

By L. G. MARSH [1]

THE relative importance of natural gas both as a domestic and industrial fuel and its increased availability through an elaborate network of pipe lines to local districts and distant centers formerly isolated from the source of supply, have contributed toward making the natural gas industry one of the pre-eminent industries of the country. In this growth and development, instruments for indicating, recording, and controlling pressures and deliveries have played a prominent part.

The advent of the regulator for effecting more uniform measurement and control in the transmission of gas from the producer to the consumer is a logical outgrowth of the demand for efficiency and conservation in an industry of diminishing reserves. The tremendous role it plays and the extent to which the industry has accepted it is evidenced in the numerous and diversified installations of regulator equipment and the different types of automatic control devices available for every range of requirement.

The regulator is the dependable unit in maintaining any desired back pressure on wells discharging into the suction of the compressor or in any distributing system where the pressure must be necessarily higher in a given portion for the desired maintenance of flow.

In the piping of gas to the refinery, the regulator will automatically supplement the refinery gas with the desired amount of natural gas when the original plant supply is insufficient for the combined requirements.

In gas fields with wells of high rock pressure, the regulator will effect the necessary reduction from each well to a pressure that can be safely handled by the transmission lines, and in conjunction with the rate volume regulator will insure only the delivery from a given well that expediency or state laws will permit. The pressure regulator and rate volume regulator will also proportion the rate of flow from each well and give a constant delivery to the gasoline plant or a constant delivery to the carbon black unit handling the field or residue gas from the gasoline plant.

The pressure regulator will insure uniformity in the delivery pressures of the residue gas from the gasoline plant to the transmission lines or for any local use to which it may be put. In the various stages of reduction from the higher pressures in the transmission lines to the lower pressures in the city distribution lines and service mains, the pressure regulator will insure consistency and uniformity in delivery pressures to the consumer under fluctuating loads or condition upsets.

In these various lines of service, the regulator has a definite responsibility in its elimination of the human element, conservation of commodity, and insurance against whatever disadvantages or disasters that might result from irregular deliveries.

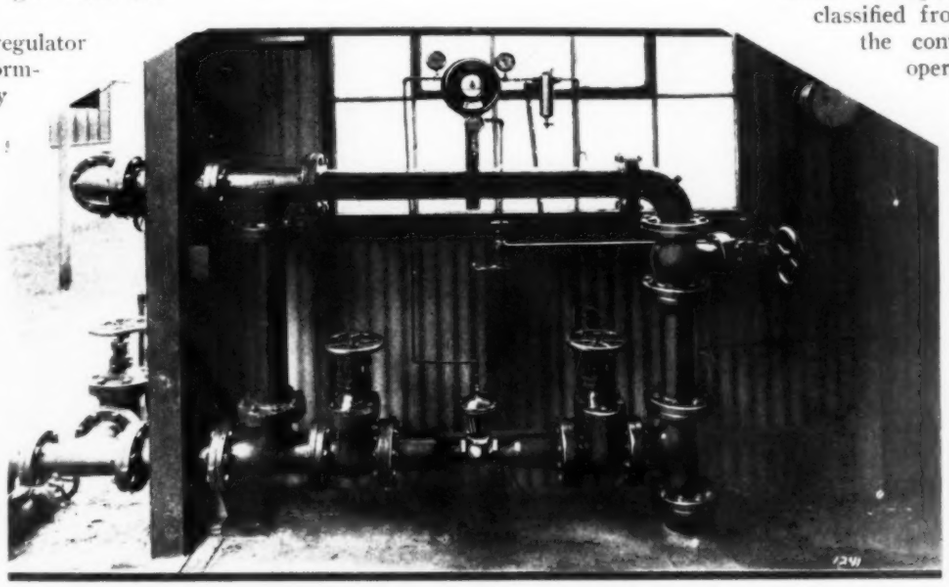
The task that confronts the natural gas industry lies in obtaining suitable control devices that will perform the functions required. It is first of all as important, however, to use indicating and recording instruments of known accuracy and reliability as it is in choosing the control instrument to do the actual work. The best equipment obtainable will not give the results desired if the instruments used in determining and checking specifications are not reliable.

There are many controllers available which may appear to be satisfactory for certain purposes. It is extremely important in selecting such equipment, however, to bear in mind the importance of the application, the specifications to be followed, the closeness of control necessary, and to investigate the principles of operation and the details of construction of the controller so as to feel confident that it will give the results expected.

The most successful regulators on the market today are the culmination of years of research and development on the part of the manufacturer toward the production of instruments having the essentials of accuracy, sensitivity, and the successful application of such instruments under the exacting requirements of industry.

Automatic pressure controls as used in the natural gas industry may be classified into two divisions—the self-acting and pilot-operated types. The self-acting regulator is so called from the fact that the instrument is entirely self-contained and operates from changes in controlled pressure direct. The pilot-operated is so classified from the fact that the controlled pressure operates a pilot valve which in turn controls the outside motive force of compressed air or gas used for actuating the control valve.

A common type of self-acting regulator is the reducing valve. This instrument is used where close control is not essential and



Direct-acting pressure regulator installation.

[1] Engineer, Taylor Instrument Cos.

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where the supply pressures do not vary greatly. It is so constructed that the reduced pressures adjacent the opening operate against a diaphragm which in turn works against a spring to close the port against the inlet pressure. The entire mechanism is contained within one housing. This instrument is limited in size and the functions it can perform. In one of its most common applications, it is used for reducing air or gas line pressures to the desired point for the successful operation of pilot-operated controllers.

The self-acting controller comprises the valve with stem connection to a diaphragm housing of comparatively large diaphragm area. The opening or closing of the valve is governed by the action of the controlled pressure working against the diaphragm with the pressure taken from a point adjacent to or distant from the valve. In its functioning to open or close the valve, the diaphragm also operates against a spring or weighted lever. The tension on the spring or the resistance of the weighted lever determines the control setting of the regulator within the given range of the diaphragm. In the reducing regulator of the self-acting type, the valve actuating pressure is the reduced pressure taken from the discharge side of the valve. Excess pressures above the control setting operate to close the valve port against the tension on the diaphragm and the high pressures on the inlet.

In the back-pressure regulator of the self-acting type, the valve actuating pressure is the controlled pressure at the inlet side of the valve. Excess pressures above the control setting operate to open the valve against the tension on the diaphragm and the high pressures at the inlet.

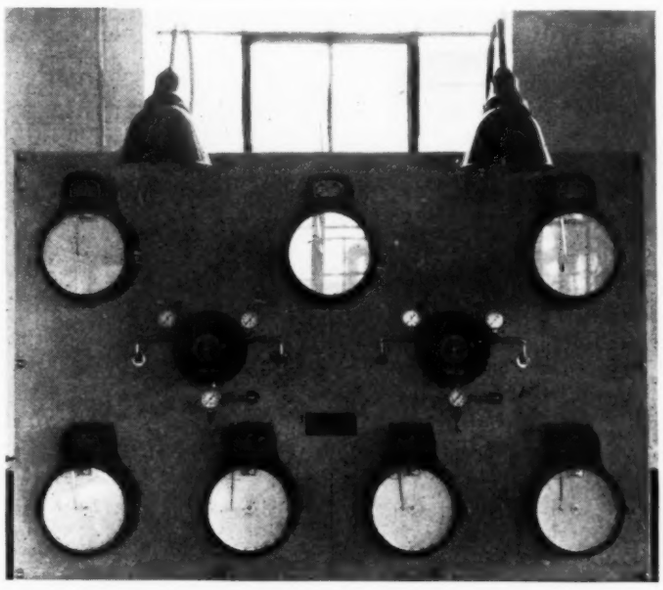
With the self-acting regulator, changes in control setting are effected by changing the spring tension against the diaphragm or by changing the position or number of weights on the lever.

The sensitivity of a regulator is a function of the pressure change necessary to cause the valve to travel from the fully open to the completely closed position, or the extent of pressure change necessary to afford a given valve travel.

The pilot-operated controller is available in several types. In each case, the instrument and the control valve are separate units. In one form the regulator proper comprises the pilot valve and capsular diaphragm. The capsular diaphragm is mounted underneath the pilot valve and contacts with it through an adjusting cam. The diaphragm inlet is connected through ¼-inch pipe to the controlled pressure area. Changes in controlled pressure cause an expansion or contraction of the diaphragm. This movement actuates the pilot valve which in turn controls the medium for operating the control valve. The control valve (or the diaphragm valve) may be either the direct-acting type which opens under spring tension with exhaust of pressure from the diaphragm, or the reverse-acting type which closes under spring tension with the exhaust of pressure from the diaphragm. The pilot valve is provided with an adjustable leak to allow the escape of the residual gas when the actuating supply is cut off from the diaphragm top of the control valve.

The type of pilot valve in the instrument proper is determined by the control valve. In maintaining constant reduced pressures, combinations would be the direct-acting regulator and direct-acting diaphragm valve, or the reverse-acting regulator and reverse-acting diaphragm valve. In the former case a rise in controlled pressure would admit the actuating medium to close the diaphragm valve; in the latter a rise in controlled pressure would cut off the actuating pressure and allow the control valve to close under the spring tension against the diaphragm.

In the case of back pressure regulation, one combination would be the reverse-acting regulator and direct-acting diaphragm valve, and another the direct-acting regulator and reverse-acting valve. With the former, an increase in controlled pressure would cut off the instrument actuating pressure and allow the control valve to open under the spring tension against the diaphragm; with the latter, a similar increase would admit the actuating medium supply to open the control valve against the spring tension on the diaphragm.



Gauge control board in gas compressor station with recording pressure and recording flow meter installations.

Indicating pressure gauges at the instrument proper will show at a glance the instrument actuating pressure, the pressure on the diaphragm of the control valve, and the actual pressures under control. The pressures on the diaphragm indicate the position of the control valve.

With the pilot-operated controller of the type described, the overall range of the controller is determined by the strength of the diaphragm, and a given setting within this range is determined by the position of the adjusting cam with respect to the pilot valve. The high degree of sensitivity that is possible is obvious when there is taken into consideration the imperceptible amount of diaphragm movement necessary to operate the pilot valve and the small extent of pressure change that can be utilized to give such movement.

This type of controller is also characterized by its flexibility as well as its sensitivity. An exchange of capsular diaphragms will change the instrument from a high pressure to a low pressure controller or vice versa. An exchange of pilots will change the instrument from a reducing regulator to a back-pressure regulator or vice versa.

Another form of the pilot-operated controller comprises the recording pressure regulator, the instrument which will record as well as control. In this construction, the pressure under control actuates a coil in the instrument proper and the overall range of the controller is determined by the strength of the coil. The movement of the coil under changes of pressure functions through the necessary linkage to operate the pilot valve and at the same time trace the pressure record on a clock-driven chart.

In the mechanics of construction and operation of the recording regulator, the movement of the coil is trans-

mitted to a baffle, which contacts with an orifice through which there is a continual escape of a part of the air or gas used for the instrument operation. The movement of the baffle against the orifice regulates the escape of gas and therefore the expansion or contraction of a bellows which actuates the pilot valve proper. The pilot valve functions to admit or cut off the actuating medium from the diaphragm valve as the flapper breaks or makes contact with the orifice. A fixed leak at the pilot valve allows the escape of the residual actuating air or gas from the diaphragm top of the control valve.

For a given control setting within a given range of the instrument, the movement of the flapper with respect to the movement of the coil determines the sensitivity of the recording regulator. The high degree of sensitivity possible is manifest in the small amount of flapper movement necessary to open or close the orifice, the multiplication of flapper movement with respect to a given movement of the coil, and the extent and flexibility of coil movement on the slightest change in the controlled pressure area. It is possible therefore even in the instrument of broad overall control range to obtain full travel of the control valve on the smallest increment of pressure change capable of being measured on the recording regulator chart.

The sensitivity of the recording regulator is adjustable to meet the individual requirements of the application. Such changes can be easily and conveniently made on the job simply by changing the position of the adjusting screw. This is in reality a change in the position of the fulcrum which effects a change in the ratio of flapper movement with respect to the movement of the coil.

One of the characteristics of the recording regulator is the direct set feature. To change the control point, the operator moves the direct set pointer to the required pressure on the chart and the instrument will control at that pressure until reset. Only one adjustment is required.

In the case of the recording regulator, the same combination of instruments and valves are possible in the various control applications as was described in the case of the pilot-operated controller of the non-recording type. With the direct-acting regulator and direct-acting diaphragm valve as is commonly used in reduced pressure control, a rise in pressure above the control setting opens the orifice in the instrument, which in turn allows the pilot valve to open to admit the actuating air or gas to close the control valve. A fall in pressure below the control setting correspondingly closes the orifice, which action closes the pilot valve and allows the diaphragm valve to open under the spring tension on the diaphragm. With the reverse-acting regulator and direct-acting control valve as is commonly used on back-pressure control applications, a rise in pressure above the control setting closes the orifice, closes the pilot valve, and allows the diaphragm valve to open. A fall in control pressure correspondingly reacts to open the orifice, open the pilot valve and admits the actuating pressure to close the diaphragm valve.

In both the reducing regulator and back-pressure regulator of the recorder controller type the pilot valve mechanism is the same. It is possible to change the instrument from the reducing regulator to the back-pressure regulator, or vice versa, by installing the proper fitting so that the flapper contacts with the orifice on a rising pressure in one case and a falling pressure in the other. The change can be easily made on the job.

The rate-volume regulator is used to a large extent in the natural gas industry for controlling the desired rate of flow from a given well to cities, gasoline plants, or other units supplied through the transmission lines. The instrument maintains the desired rate of flow by automatically controlling the maximum pre-determined value of the differential, and records as well as controls. For the given size of orifice, the desired maximum rate can be changed by the direct set arm located in the case of the instrument. All the operator needs to do is to turn the pointer to the desired differential and the instrument will control at that point.

The rate-volume regulator is an adaptation of the orifice meter and is rugged, yet extremely sensitive. The differential gauge portion of the instrument responds quickly to any change in the rate of flow and the movement of the differential pin shaft promptly operates the pilot valve. This in turn controls the actuating air or gas which operates the control valve. Through the extent of linkage movement at point of contact with the pilot valve for a given change in differential, and from the small amount of movement necessary to open or close the pilot, the rate-volume regulator is responsive to the smallest increment of differential pressure change capable of being measured on the orifice meter chart.

The rate-volume regulator can be applied where the control valve opens or closes with application of air or gas pressure on the diaphragm. In either case the pilot valve is the same and the instrument is adapted to the particular valve action by reversing the movement of linkage.

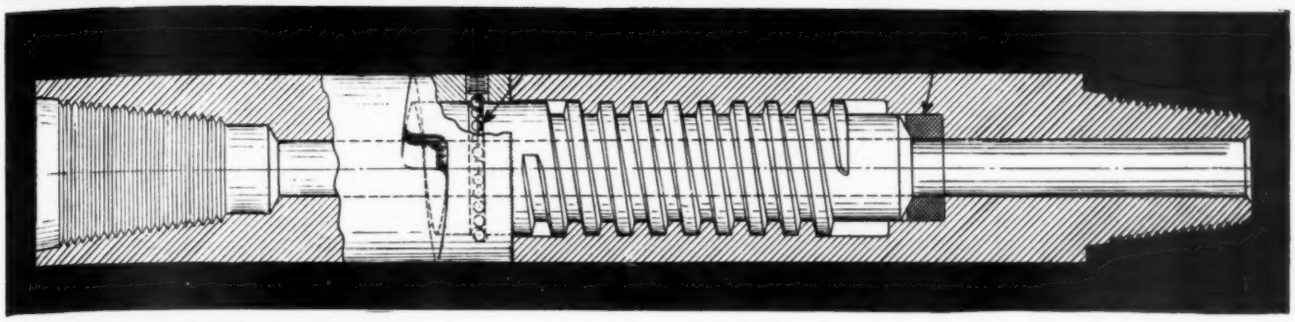
The success of any regulator installation for the control of pressures or flow is dependent on the proper size and selection of control valve. The action of the pressure or flow controller in the natural gas industry is essentially throttling and this is possible both through the construction of the instrument, the design of the valve, and the proper co-ordination of action between the two.

In this day of industrial progress where competition and cost of production afford smaller profit margins in the sale of the commodity, the natural gas engineer is giving more attention to the factors of measurement and control. The item of control is particularly important, for the smoothness of regulation determines in part the accuracy of measurement. The difference in sensitivity of the regulator equipment in its twenty-four-hour service day after day, week after week, month after month can cause an appreciable difference both in the returns to the producer and service to the consumer. In the control of pressures in high pressure transmission lines, a five-pound closeness of control which once was acceptable is now intolerable. Through pilot-operated controllers as now in evidence in the gas fields of the Southwest, the producer can carry a transmission pressure as high as 400 or 450 pounds with a variation no greater than one or two pounds.

The automatic pressure controller of the pilot-operated type is not limited to the control of fixed pressures, but is also adaptable for the control of pressures in relation to time. In such construction it is applicable in the present-day problems of delivery to cities or communities where the variable demand between night and day, or morning and evening, makes it necessary to carry higher pressures in the lines at different times to meet the increased demands. The pilot-operated controller can control delivery pressures in accordance with any predetermined time and pressure schedule. It is possible also through a combination of control equipment to go even a step further, and that is to automatically control delivery pressures with reference to atmospheric temperature so that a given pressure can be carried in the line in the warmer days when the needs are moderate, and a high pressure in the colder periods when the needs are more insistent.

Through the variety and extent of control devices available and the experience on the part of the instrument manufacturer in their practical application, an installation to meet practically any control problem is possible.

3 FEATURES



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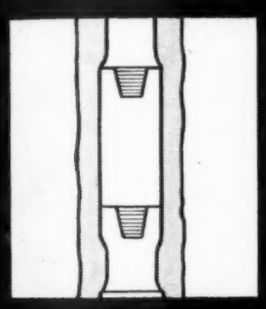

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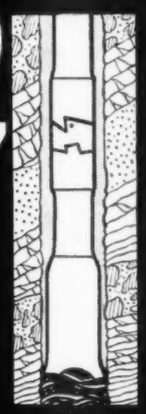

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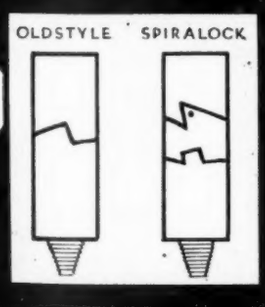

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In operation, the SPIRALOCK Safety Joint provides positive release under all drilling conditions. With its 3 to 1 release safety factor, the danger of freezing long strings of drill pipe is positively eliminated. Only one-third of the pressure is required to break this safety joint that it takes to break the tool joint. The rubber packing ring prevents circulating fluid from working into the threads. Acid bottle test readings are accurate as the inside diameter of the joint is identical with the drill collar, permitting unobstructed passage of the acid bottle to the bit.

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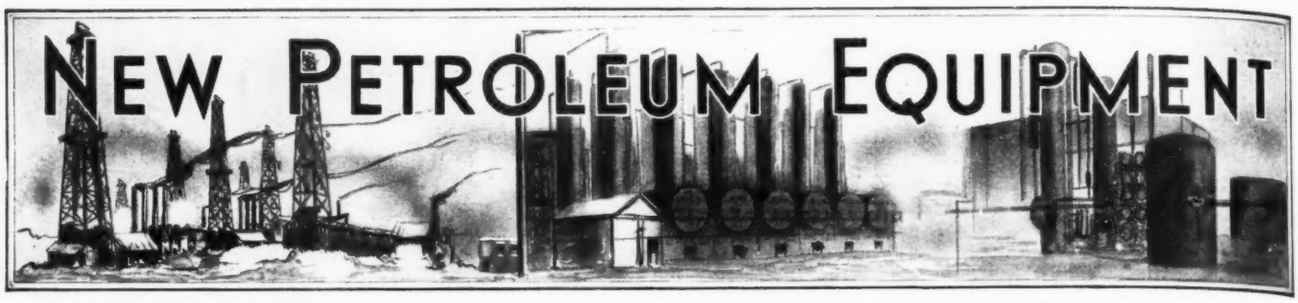
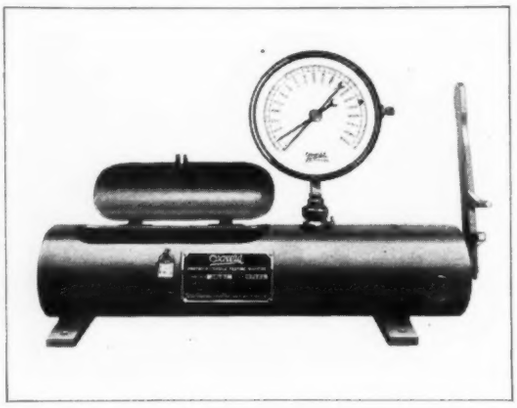


Portable Machines For Testing Welds

OXWELD ACETYLENE COMPANY, 30 East 42nd Street, New York, announces the Oxweld Portable Tensile Testing Machine, designed to facilitate the testing of welds in the field or shop. This machine was developed in co-operation with Union Carbide and Carbon Research Laboratories, Inc., and is being sold as a standard piece of Oxweld equipment.

This machine weighs 165 pounds and measures 28 inches in over-all length and 6¾ inches in maximum diameter. It is a self-contained, totally enclosed unit. When closed for shipment, there are no projections and the machine presents a comparatively smooth cylindrical surface.

The machine consists of a tubular compression member with a set of grips in the head and a hydraulic cylinder block in its base. The cylinder block contains a communicating pump and cylinder directly machined into a single block, and the cylinder pressure operates a piston carrying a second set of grips.



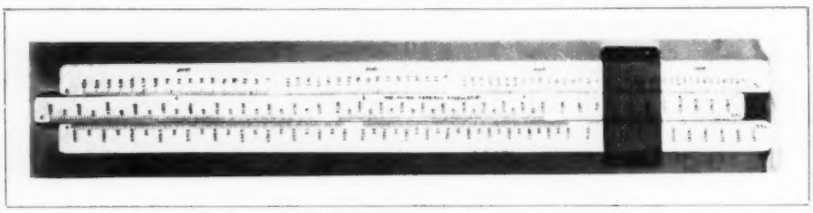
The specimen to be tested is placed between the jaws, which have spring grips. The release valve is closed and the pump handle, applied at the end of the cylinder, is moved back and forth. A set of conical blocks has also been constructed to fit into the machine head in place of the grips so that the standard ½-inch diameter round specimens may be tested if desired. The load is measured directly in pounds per square inch by a suitable, calibrated pressure gauge actuated by the pressure in the cylinder. When a test is finished the pressure may be released by a valve and the piston may be returned to its original position by using the pump handle as a lever.

Ac-Me Tank Car Calculator

THE Ac-me Tank Car Calculator placed on the market by the Refinery Supply Company, Tulsa, is for the purpose of figuring corrected tank car volumes; scales being provided for tank cars of 6,000 gallon, 8,000 gallon, and 10,000 gallon capacities.

Temperature scales are also provided for oils of various gravity, and there is a temperature scale for the following co-efficients of expansion: .0004, .0005, .0006 and .0007.

The calculator is 18 inches long and is made of magohany, faced with white celluloid, on which the various scales are imprinted. The scales are accurately graduated and the instrument can be read accurately to within one gallon.



In operating the calculator the proper temperature scale is picked out and the corresponding pointer on the temperature at which the car was gauged is set. Then set the hairline indicator on the volume gauged, found on scale "B", and read on scale "C" the volume corrected to 60 degrees F. Move the slide so that the hairline indicator in its present position indicates on scale "B" the shell-full capacity of the car. Then the pointer will indicate on scale "A" (under the proper co-efficient of expansion) the temperature at which the tank car will be shell-full.

Guiberson Wire Line Oil Saver

A NEW product of The Guiberson Corporation, Dallas, Texas, is its wire line oil saver, designed to reach new heights of efficiency, economy and simplicity of operation. The rubbers are brought together evenly, instead of one at a time, and with equal pressure, insuring a perfect pack-off, avoiding uneven rubber wear and prolonging the life of the rubbers. A very handy and desirable feature is the ability to remove the roller caps with their enclosed rollers without disturbing any other part of the saver. Bottom rubbers are made for the express purpose of sealing fluid while the upper rubbers are being changed, a very desirable feature. The crank effort is compounded through worm and toggle arms to the rubbers. The movement of the crank by hand or the mere touch of the crank handle by the toe of the foot is sufficient to pack off against the highest pressures.

The Bullseye Drift Indicator

THE Bullseye Drift Indicator, manufactured by the Bullseye Instrument Company of Los Angeles and distributed by the Petroleum Equipment Company of the same city, is one of the latest instruments for determining the drift of oil wells from vertical.

The "heart" of the instrument is a non-magnetic free swinging pendulum, the point of which is free to hang 1/16 inch above a steel grooved bullseye disc. The pendulum bearings are mounted on the end of a plunger which works through a stuffing box, the packing of which is held in place by a packing nut. A head is fastened to the top of the plunger. The pendulum housing assembly is screwed into the top of the tubular go-devil body which is six feet long and one and one-half inches in diameter at its maximum point. In the bottom end of the body is a shock absorber, and in its sides are centering springs.

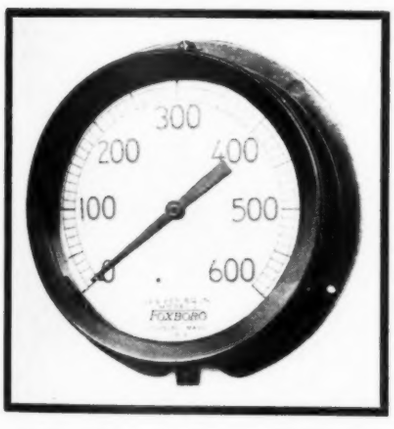
Its operation is as follows:

Top of the body is filled with light oil

to deaden pendulum swing and pendulum assembly is screwed into place with plunger cap pried up so that pendulum swings clear. The instrument is dropped into drill pipe and kelly is unscrewed when the drill pipe is to be pulled. Instrument drops through drill pipe at the rate of from 1,500 to 2,100 feet per minute and lands in drill collar on top of the bit. A pipe striker is dropped in the drill pipe about two minutes after dropping the indicator. The pendulum comes to vertical rest about ten seconds after the instrument reaches the bit. The striker then hits the plunger head, forcing the plunger to slide through the packing, which causes the spring point of the pendulum to lock in the groover over which it is hanging. When the drill pipe is removed and the instrument recovered from the drill collar, the vertical deviation of the hole is read from the position of the pendulum point. The plunger is then pried up and the instrument is ready for the next run.

Foxboro Announces a Refinery Gauge

THE Foxboro Company has developed an indicating pressure gauge that is designed specifically for oil refineries. All of its parts that are subject to pressure are of steel and are sweated and screwed tightly into place. This insures against leaks developing due to high pressure, high temperature conditions. In case of fire its parts will not give way and thereby add inflammable fluid to the flames.



Particular care has been taken in the detailed construction of this indicator. A special alloy steel Bourdon spring is used which allows the gauge to be operated continuously at maximum scale reading without fatigue. The flanged case is of cast iron and is made one hundred per cent fume-tight. It has a cast iron threaded ring fitted with double thick glass litharged in place. The movement of the gauge is all steel and care has been taken to make it extra sturdy. It has cadmium plated movement-plates, steel hair spring, extra wide bearing surfaces and hardened steel parts to withstand vibration and excessive pulsation. The dial and pointer are of stainless iron, which insures permanency and no discoloration.

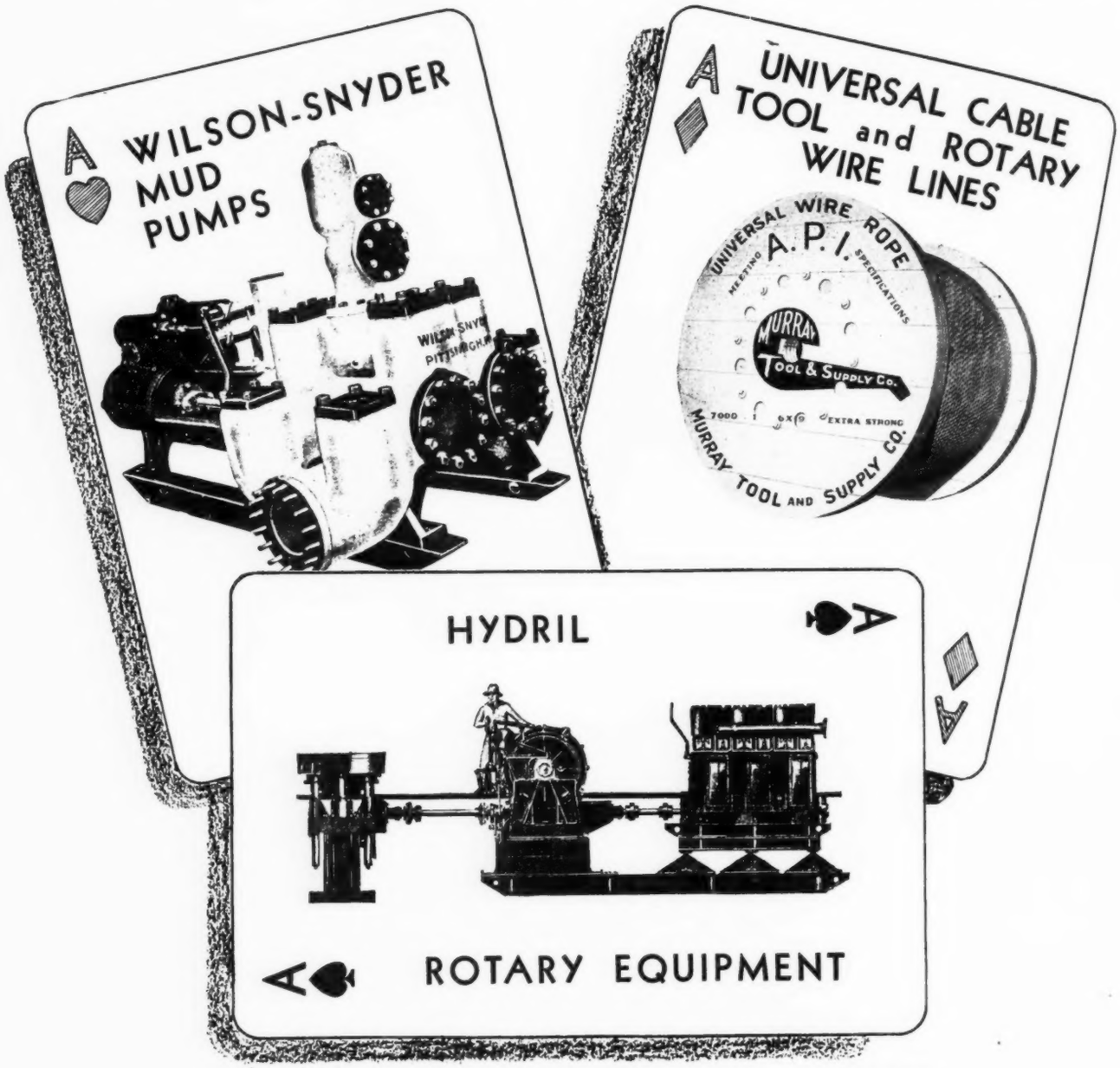
The refinery gauge is furnished only in a six-inch size with bottom connection, forged steel socket, one-quarter-inch male S. P. T. Pressure ranges available at the present time are: 0-300, 0-600 and 0-1000 pounds per square inch. Additional information on this gauge may be had by applying to the Foxboro Company, of Foxboro, Mass.

Crum-Brainard Company, Ltd., Enters Oil Field

THE Crum-Brainard Company, Ltd., with offices and shops located in Whittier, Calif., recently announced its entrance into the oil tool sales and manufacturing field. This new concern is headed by R. R. "Rol" Crum and F. W. "Barney" Brainard, two prominent drilling and production tool engineers, whose combined oil tool experience amounts to over fifty years.

At the present time the concern will carry sales on the Crum-Brainard cathead and the Crum-Brainard rotary booster brake. Along with these two tools they will carry both sales and service on the Crum-Brainard core barrels and core bits.

NOT ONE but THREE



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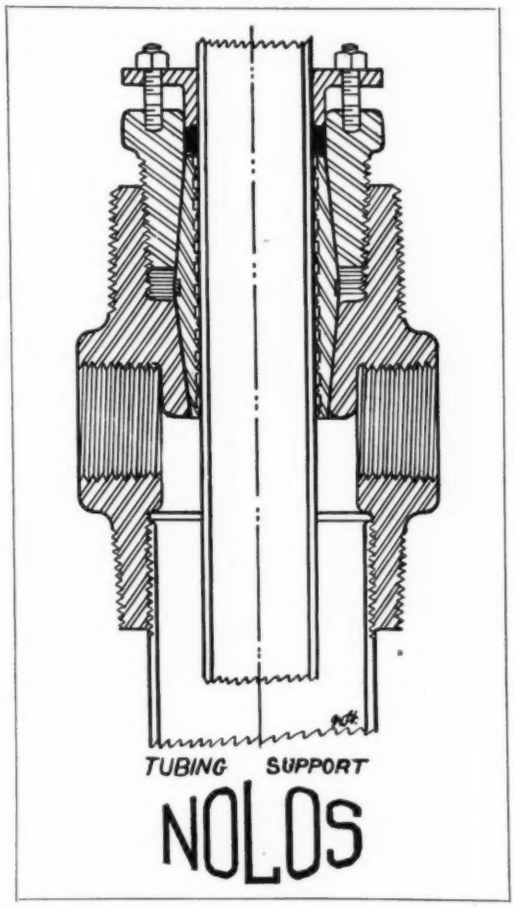
Emergency Features in O. W. I. Tubing Support

THE tubing support being marketed by The Oil Well Improvements Company has the novel features of being threaded on the bottom and top for two different sizes of casing, making it possible to make various combinations of connections and to use an upper joint of casing as an over-shot when necessary.

The tubing support screws on to the casing and has a conventional tapered seat to receive slips to support the tubing. The slips, however, are tapered toward each end and are so made as to not only support the tubing, but as an anchor to prevent the tubing blowing out of the well. An anchor ring furnishes the taper support for the upper part of the double tapered slips.

Above the slips is a packing ring and gland to prevent loss of gas or fluid around the tubing. The slips are held in horizontal alignment by a flat spring encircling the middle portion and holding the slips in close contact with the tubing at all times. This permits the slips to be withdrawn with the tubing when the latter is pulled and also compels a uniform pressure on the exterior of the tubing, eliminating danger of crushing due to unequal loading.



Pipe-Wrapping Machine

A PIPE-WRAPPING machine, which applies felt to pipe lines at the rate of 30 feet of pipe line per minute, is a recent contribution to the industry by the Resistcor Engineering Corporation of Tulsa.

The machine is made in two models. Model A, for wrapping two-inch to 10-inch lines, inclusive, is hand-operated. Model B, for lines 12 inches or more in diameter, is operated by a one-cylinder, two-cycle, air-cooled engine consuming an average of three quarts of gasoline in 10 hours. Only two men are required to operate either model.

The manipulation of only four bolts permits the removing or putting on to the line of the machine.

A wiping mechanism, following the felt, removes the wrinkles and unevenness. Rubber surfaced wheels on the line truck protect enamel-coated lines from damage.

New Type Spencer Trailer

THE Spencer Trailer Company of Augusta, Kansas, has a new trailer of ten-ton capacity that uses a Tandem Axle Pole Trailer. This Tandem Axle Trailer makes possible the hauling of heavier loads with less strain on tires, springs and other parts and at the same time protects and complies with road law restrictions. The gears of this trailer are primarily designed for use under van bodies and tank trailers.

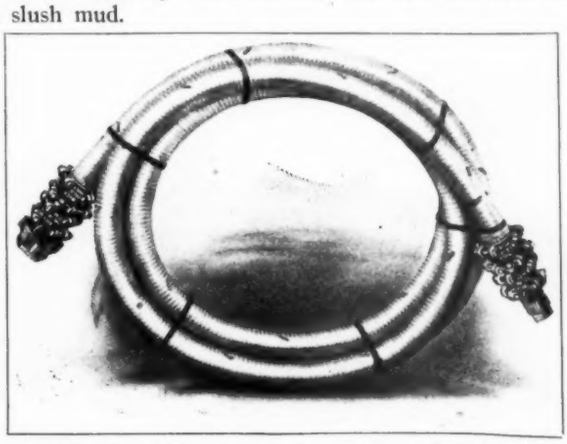
A Model "TH" ten-ton will be shown at the Exposition. It is equipped with eight forty by eight heavy duty tires. The company also produces this type of trailer in two lighter sizes, four and six-ton capacities.

Super Goodall Semi-Metallic Rotary Hose

NEW SUPER is the trade name applied to a recently developed rotary drilling hose, covered by patents, with additional patent pending.

The New Super G. S. M. has been developed to such a degree of strength as to answer the increasing higher pressure pumps for extra depth drilling.

It is completely protected from exterior wear and abuse by the G. S. M. Free Flexing ball joint steel armor and with inner construction built up with metal members to prevent elongation. The inner tube is of the highest grade rubber to effectively resist the wear and abrasion from sand and slush mud.



Each length of New Super G. S. M. before leaving the factory, when coupled with the improved Boss Tri-Duplex Coupling, is tested to 4,000 pounds per square inch in the two and one-half-inch size, which is the size most generally used.

This hose is manufactured by the Goodall Semi-Metallic Hose & Mfg. Company of Philadelphia, Pa.

BITS

THAT ARE BUILT TO DRILL STRAIGHT, FAST AND FAR

The "business life" of a Spang Drilling Bit is scientifically predetermined before the Bit is shipped. This is true of every Bit that leaves the Spang plant—regardless of its size or type. If you could watch us selecting the steel, testing it, forging it, inspecting it, heat-treating it, and inspecting it again—you'd know why SPANG Bits set a higher standard, a faster pace, and a lower cost for every foot of hole you drill.

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Baird Fire Snuffer

THE Baird Manufacturing Company of Tulsa, Okla., is presenting an improvement in fire-fighting devices to prevent or instantly combat the unexpected ignition of oil or gas while drilling in, eliminating the usual hazard always at the rig.

A means is provided for an internal circular delivery of steam directly into the combustible flowing column by utilizing the velocity of the fluid or gas coming out of the well to create the required pressure necessary to combat the rock-pressure of the well, and introduce the steam into the column, for it can be readily seen that 350 pounds boiler pressure will not successfully buck 1,000 pounds rock pressure.

A means is also provided for the external delivery of water, steam, or fire-extinguisher fluids to surround the rising body and put out ground fires on the rig or in the cellar.

The installation is made by screwing the head on each string of casing run where gas is to be encountered. This does not interfere with the normal operation of cable or rotary tools, as the internal diameter of the snuffer is the same size as the casing string. Lines are then connected and run to the boilers, ready for instant opening should the emergency arise.

The ability to instantly fight the unexpected fires at the mouth of the open well flow insures greater safety to men and equipment as well as eliminates costly replacements and shutdown time. Contractors whose liability extends to their own tools after the well is down to bottom will insist on the use of this or some such similar device.

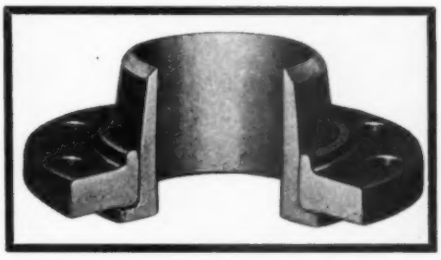
The Oklahoma City fire department watched an interesting test recently when with but normal city water pressure of 40 pounds a circular wall of water was forced up around a casinghead for a distance of twenty-five feet.

The illustration shows the Baird snuffer with a partial inside view. Lips showing inside are recessed back from the wall of the snuffer, and the force of the rising column of oil or gas creates a partial vacuum behind these lips sucking the stream in with the rising column, thus giving the operator all the pressure of the well itself plus that provided by the boiler. Sufficient tie-ins are provided for four boilers if the operators desire that many.

Bulletins covering the device will be furnished by the manufacturers on request.

"Merco" Swivel Flange

A NEW type of flanged joint has been developed for use in connection with welded pipe lines where such a joint is required for the insertion of valves and fittings for the taking off of outlets. It is known as the "Merco" Swivel Flange and is a unique device possessing fully the inherent flexibility of the Vanstone type of flange, plus the strength of an ordinary butt welded flange, according to the manufacturers, Merco Nordstrom Valve Co., San Francisco, Calif. It consists of a drop forged steel flange, fitted to a drop forge tapered nipple on which the flange may be rotated, permitting alignment of bolts, etc. The tapered nipple is forged from a solid steel billet and the finished product incorporates a thickness much greater than pipe at the base of the nipple where highest stress occurs. Being formed completely at the proper forging temperature, possibility of a fracture of the metal is minimized. The manufacturers state that by forging from a solid billet sufficient heat is stored up in the steel to permit operation being finished at the correct forging temperature.

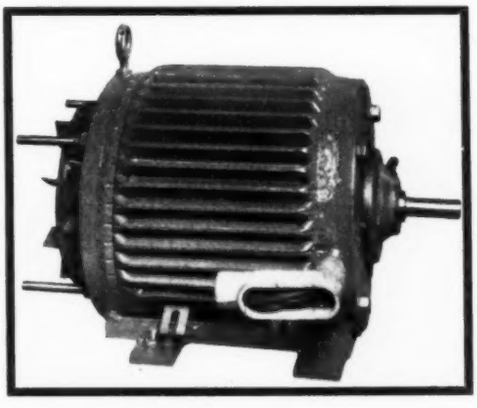


An advantage of this swivel flange lies in its flexibility, having equally as much as the ordinary Vanstone type of flanged joint.

The manufacturers are arranging production to soon make available sizes from 1½ inches to 10 inches, and specifications are to meet the American standards in strength requirements.

Totally Enclosed Fan Cooled Induction Motor

A TOTALLY enclosed, fan cooled induction motor which embodies numerous new and unusual features has recently been announced by The Lincoln Electric Company, of Cleveland, Ohio. This new motor is so ingeniously designed that its rise in temperature is said to be considerably less than the allowable rise for motors of this type. The design of this motor also includes arc welded steel construction, double sealed ball bearings, and a removable cover which facilitates easy cleaning of the radiating surface.



The large radiating surface is obtained by complete enclosure of sides of the motor with a deeply corrugated sheet of corrosion resisting metal. This conducts the heat created within the motor to its outer radiating surface which is constantly cooled by a continual draft of fresh air passing over the radiating surface. The air imprisoned within the completely sealed frame is constantly circulated by a fan arc-welded to the rotor. This fan drives the heated air within the motor to continuous contact with the large corrugated cooling surface. The outside air which drives the heat from the radiating surface is forced over the exterior of the corrugated surface by a large fan attached to the motor shaft. The outside air is drawn in at one end and expelled at the other end.

The Bates Expanded Steel Pole

THE Bates Expanded Steel Corporation of East Chicago, Indiana, has developed and placed on the market the Bates expanded one-piece pole for the support of overhead pipe work.

The pole is made by slitting the web of a rolled beam section, heating, and then expanding this slitted beam into a one-piece truss having neither rivets, bolts nor weld.

These standard poles take the transverse loads set up by heavy winds on large pipe surfaces, as well as the compression load of heavy pipe, with an ample known safety factor.

Rotary Temperature Regulator

A UNIQUE new type of rotary-stem reducing or back pressure regulator for high temperatures and pressures is now being made by Neilan Co., Ltd., manufacturers of automatic regulating and controlling equipment. The modern high temperature cracking, refining and industrial processes utilizing both high and low pressures require an improved type of regulator. This novel regulator is made with a rotary stem because it is much easier to keep tightly packed at high temperatures and pressures than the common sliding stem type.

Neilan Rotary Stem Reducing or Back Pressure Valve

Dangerous leakage is impossible with this advanced Neilan controller even at high temperatures and pressures.

Special types of stuffing boxes are furnished for every different operating condition.

The valve bodies are made of high strength chrome-alloy cast steel, while the valve plugs, valve seat rings, complete rotary stem linkage and many other parts are made of non-corrosive, Nirosta KA2 stainless steel. Friction is eliminated by means of stainless steel ball bearings which are used throughout the construction of this new Neilan Regulator.

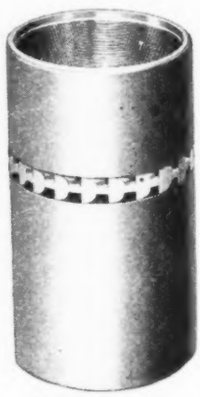
Descriptive literature may be obtained from any Neilan Engineer or by communicating with Neilan Co., Ltd., 641-651 Santa Fe Ave., Los Angeles, Calif.

Improved Baash-Ross Cement Guide and Collar

AN IMPROVED type of cement guide and collar, which insures uniform distribution of cement all around the casing, is now on the market by Baash-Ross Tool Company, after being tested for several months by major oil companies.

The distinctive feature of these tools is a rotor, similar to that of a steam turbine or centrifugal pump, which moves freely in a groove in the body. Cement is forced through a series of radial holes, striking the vanes of the rotor and causing it to revolve. The effect is the same as though the casing revolved—throwing the cement outward with a whirling or centrifugal motion in a continuous stream which completely fills the surrounding space.

Baash-Ross centrifugal cementing guide, regular pattern.



Cementing collar.

Cementing guide, special pattern.

This construction prevents leaving passages through the cement, commonly known as "channeling," which defeat the purpose of the cementing as a complete seal.

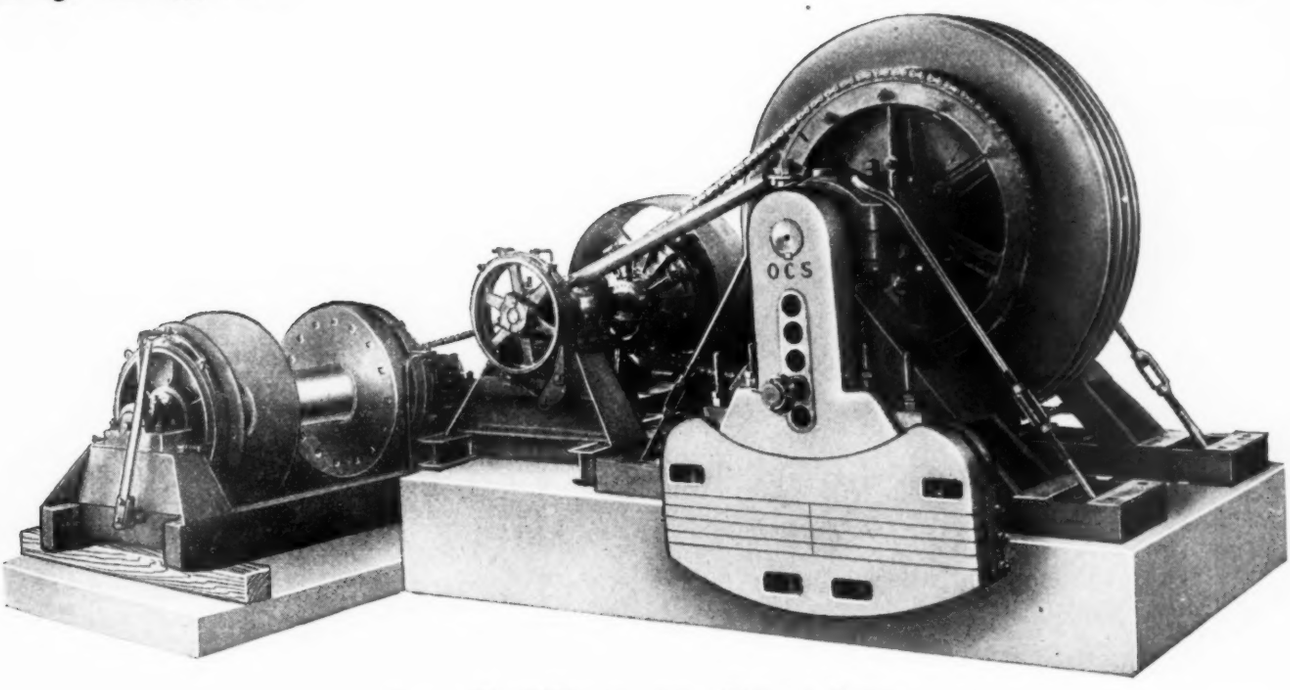
Three types are available; the regular cementing guide, the special guide, and the cementing collar. The regular guides and the collars distribute the cement horizontally. The special guide has its rotor mounted on a 45-degree angle toward the bottom of the well, to produce an effective seal below the edge of the shoe.

Bulletin 81 describes the guides and gives complete information. It may be secured from the company.

OCS

Universal Rig Fronts

Any Engine **Any Motor**



for Drilling or Pumping

The Deepest Wells in the World

Manufactured by

THE OIL COUNTRY SPECIALTIES MFG. CO.

COFFEYVILLE, KANSAS

HYNES, CALIF. TULSA; SEMINOLE, OKLA. SWEETWATER; HOUSTON, TEXAS HOBBS, N. MEXICO

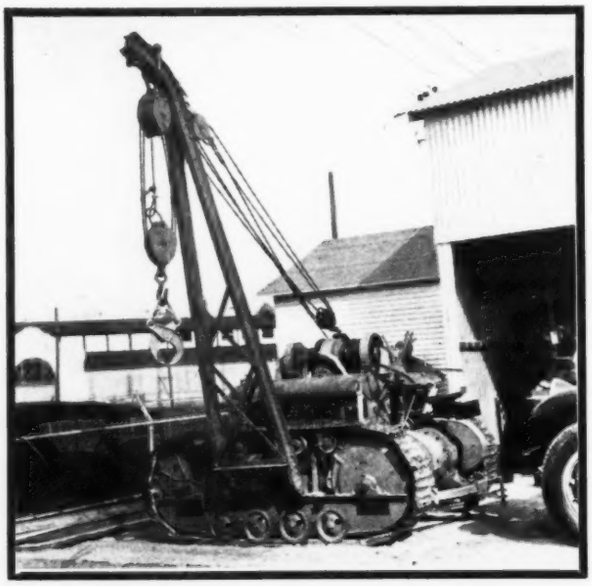
HILLMAN-KELLEY, INC., 2437-39 HUNTER ST., LOS ANGELES, CAL.

When writing THE OIL COUNTRY SPECIALTIES MFG. CO. *please mention The Petroleum Engineer*

Trackson-Fordsons in use on Pipe Lines

FIVE Model D Trackson-Fordsons equipped with Berg Booms are working on the Sinclair oil line near Oilton, Oklahoma.

Trackson Company, Milwaukee, Wis., state Fordson tractors equipped with Trackson Crawlers and Berg Booms offer a rugged, yet very flexible unit, with ready power, sure footedness and positive traction.

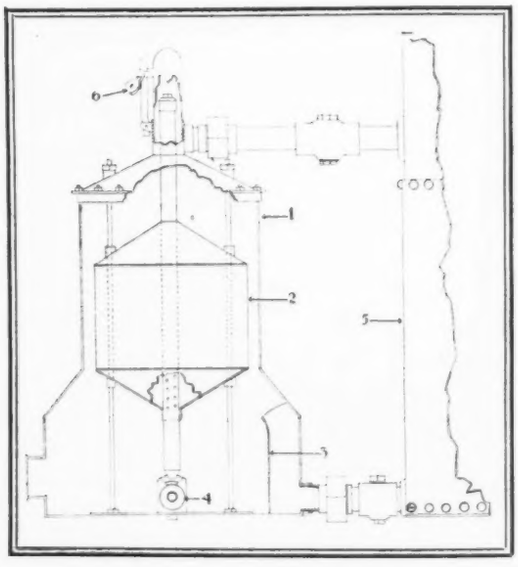


The Berg Boom is manufactured by the Resistcor Engineering Corporation, Tulsa. It was developed by Matt Berg of the Cushing Motor Company, Cushing, Okla., who is a practical pipe-liner.

The Berg Boom is a live boom job, moving up and down to pick up or lower the pipe. It is mounted directly to the crawler frames, and the hoisting drums are so mounted that they help to counterbalance the weight of the boom. The lever controls of the hoisting mechanism are close to the driver's right hand and there is no obstructing framework to interfere with his vision.

Automatic Oil and Water Separator

J. W. PIPPIN, Box 1493, Corpus Christi, Texas, has designed the Pippin automatic oil and water separator for the purpose of bleeding all free water out of storage tanks of oil. It has an automatic shut-off to prevent the escape of the oil.

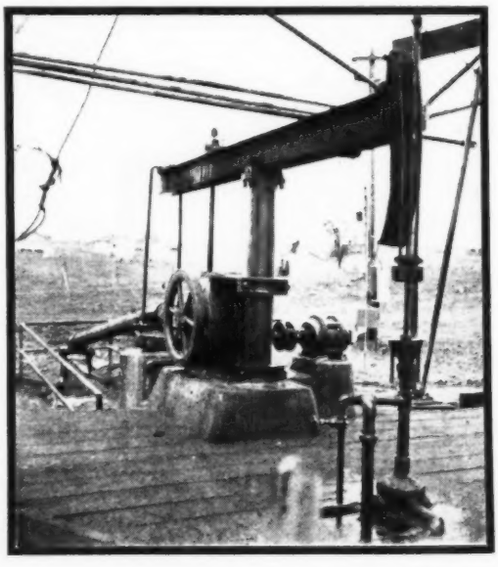


The principle upon which it works is the difference in weight of water and oil.

An explanation of the drawing: Section of flow tank (5), or gun barrel, into which the separator is connected as seen: 1, Outer jacket; 2, float or hydrometer which sinks in oil but floats in water; 3, baffle plate that directs oil upward and water down and out through valve (4), which closes automatically when all water is out of tank; 6, padlocked, which prevents tampering.

American 4-A Pumping Unit

THE American Well Works' No. 4-A, Fig. 1822, Oil Well Pumping Unit is this company's latest development in its line of individual pumping units for oil wells. This line consists of six sizes of machines with strokes varying from 12 inches to 50 inches and for depths ranging from the shallowest wells to 4,500 feet.

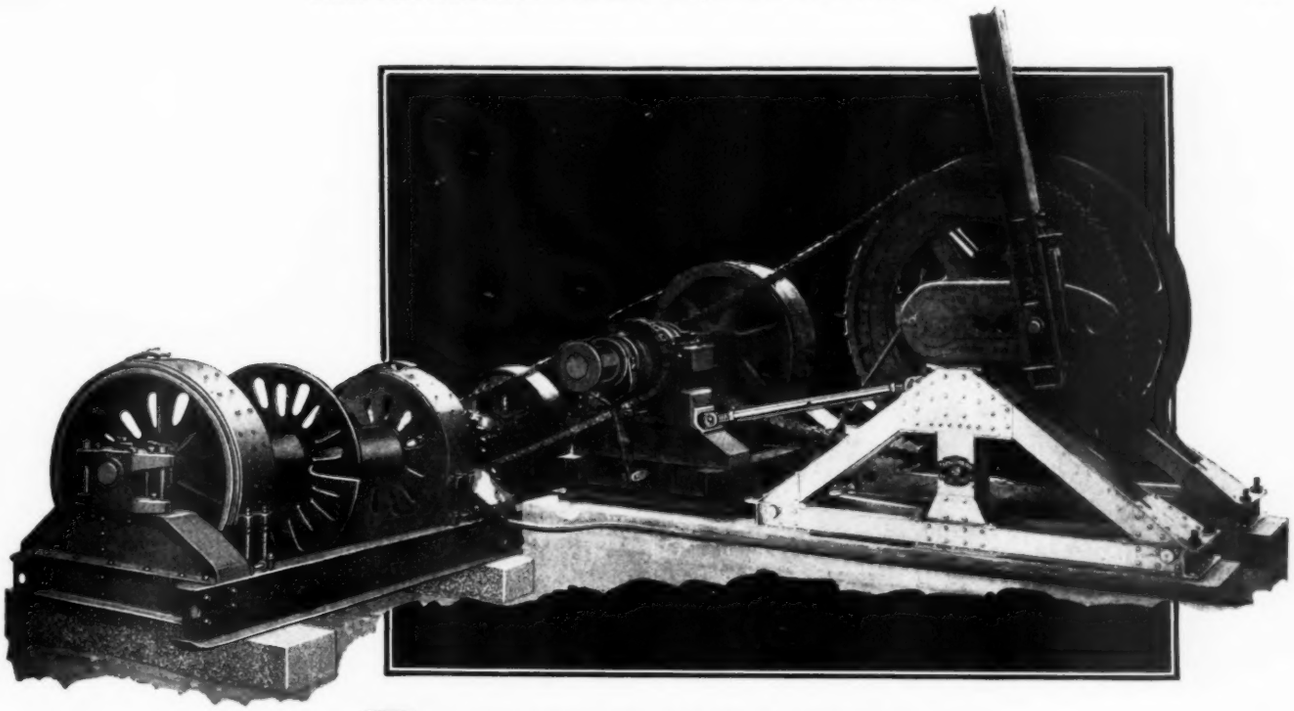


The No. 4-A unit is for wells as deep as 3,200 feet and has four strokes from 21 inches to 36 inches. It is made for either direct motor drive or for belt drive.

The sampson post support is an integral part of the heavy gear case casting, making a fabricated sub-base unnecessary.

Gears, pinions and all bearings in the gear case—including the bearing at the lower end of the pitman, are self-oiled.

Complete information will be furnished by the American Wells Works, Tulsa, Dallas, Houston, El Paso or by the main office at Aurora, Ill.



PARKERSBURG CHAIN-DRIVEN RIG FRONT

A compact Operating Unit for today's and tomorrow's oil wells. Adapted for use with any derrick and any power—electric motor, steam or gas engine.

Combines such quality features as, self-aligning roller bearings, A. P. I. Standard sprockets and keyways, triple tug wheel, and structural steel riveted and welded mounting. The unusual stability of all-steel construction, the engineering knowledge and experience put into Parkersburg Equipment for more than a third of a century assures its performance and economy.

Write for further data or ask a Parkersburg Man

QUALITY

From DERRICKS To TANKS

SERVICE IN EVERY FIELD

Main Offices and Works

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251-A

When writing The Parkersburg Rig & Reel Co. *please mention The Petroleum Engineer*

RUNNING TOUR With Men In The Industry

H. S. Austin

H. S. Austin, president, and H. M. Stevenson, chief engineer, of the Ajax Pipe Line Company, sailed for Iraq the latter part of November. They will make a survey for a pipe line from Iraq to the Mediterranean sea, after which they will return and draw up the plans.

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H. O. Waters is the present farm boss for The Texas Company at Fry, Texas, in the place of J. R. Daugherty.

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Paul R. Turnbull, engineer with the Humble Oil & Refining Company, has been transferred from Odessa, Texas, to McCamey, Texas, where the company's West Texas division offices are located.

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George W. Newman has become production superintendent for Courtney B. Davis, Kansas operator and producer. Mr. Newman is now located at Hillsboro, Kansas.

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A. W. Lindley, formerly field superintendent for the Healdon Oil & Gas Company at Covington, Okla., is now production superintendent for the Eason Oil Company at Enid, Okla.

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W. H. Dempsey, production superintendent for the Buckeye Oil & Gas Company, is now general superintendent and is located at Cleveland, Ohio.

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J. C. Brokaw is the new production superintendent for the Texas Construction Company, Houston, Texas.

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L. M. Goldsmith, vice-president of the Atlantic Pipe Line Company, sailed for Europe on November 26th. He will return shortly after the first of the year.

H. S. Greene

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H. S. Greene, formerly general sales manager of the Barber-Greene Company, Aurora, Ill., has been elected to a similar position with the Chain Belt Co. of Milwaukee, Wis., manufacturers of chain conveying and construction equipment. Mr. Greene has been in charge of the coordination of sales and distribution for the company since 1929.

Frank Mason, Los Angeles representative The Shaffer Tool Works, is settled in new downtown headquarters which have been opened in the Subway Terminal Building, 417 South Hill Street, Los Angeles. Mason was formerly superintendent of the Brea plant and this summer spent several months in the Mid-Continent representing his company. Norman LeRoy is assisting Mr. Mason in the Los Angeles office.

Frank Mason

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J. R. Daugherty, formerly farm boss for The Texas Company at Fry, Texas, is now superintendent for the Arcadia Refining Company, with headquarters at Coleman, Texas.

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R. H. Crow, superintendent of the Haynes Bros. Drilling Company, is now in Shreveport, La. He was formerly located at Oklahoma City.

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J. B. Reilly of the Fluid Packed Pump Company, Inc., Los Neitos, Calif., is visiting the Tulsa offices of the company. While in the Mid-Continent he will cover the important points, also remaining to attend the opening of the new Mid-Continent offices of the company at Oklahoma City about December 10.

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E. F. Sparks has been moved from Rising Star, Texas, to Odessa, Texas. He is district superintendent for The Texas Company.

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C. Marinescu, drilling superintendent for the Steaua Romana Oil Company, Moreni, Roumania, is in California making a survey of drilling methods there. Victor Dumitrescu, engineer in charge of production for the same company, is also in California studying American drilling methods and equipment.

A. H. Mayo

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A. H. Mayo, formerly with Motor Fuel Products, Inc., at Laredo, Texas, is now general manager of the Grayburg Oil Company, with headquarters in San Antonio, Tex.

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S. P. Tschappat of the Hercules Tool Company, Tulsa, is spending the holidays with his mother and other relatives in Ohio and Pennsylvania. He will return to Tulsa about January 1.

W. L. Muir has been elevated from the position of assistant purchasing agent to that of purchasing agent for the Indian Territory Illuminating Oil Company at Bartlesville, Okla. He succeeds H. D. Patridge, who has been made manager of the recently-created purchasing, stores and traffic division of the company. Mr. Muir is only 31 years of age, but has had much experience in the purchasing of oil field supplies.

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John R. Huffman has joined the staff of the research laboratories of the Standard Oil Development Company, Elizabeth, N. J., after a year of research work at the University of Copenhagen.

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John H. Scott is the new superintendent of the Oklahoma City machine shop for the Indian Territory Illuminating Oil Company, succeeding P. J. Wines.

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J. S. Ross of the Southern States Company, Inc., has moved from Shreveport, La., to Tulsa, where his address is 1409 South Quincy Street.

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A. H. Shafer has been recently appointed manager of The Foxboro Company's Pittsburgh, Pa., office, replacing H. S. Gray, who is now in charge of office routine at the home plant.

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R. C. Chamberlin, Tulsa, Okla., representative, Ridge Tool Company, has returned to Tulsa from a three weeks trip to the Gulf Coast territory.

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B. C. Rogers, superintendent of tools for the Gulf Production Corporation at Pampa, Texas, is taking a six months leave due to ill health.

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Earl E. Deacon, formerly in charge of Oklahoma sales for the Chicago Pneumatic Tool Company, has been appointed representative of the Oklahoma City district, with headquarters at Oklahoma City, for the Broderick & Bascom Rope Co.

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F. Laverne Miller, formerly research assistant at the University of Michigan, is a new addition to the research laboratories of the Standard Oil Development Company at Elizabeth, N. J.

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G. H. Bolle has been appointed district representative in the New York territory for the Coppus Engineering Corporation. Mr. Bolle has been with the company for a great many years. He will make 120 Liberty Street, New York City, his headquarters.

Frank A. Zimmerman

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Frank A. Zimmerman, who has been in charge of the Indian Territory Illuminating Oil Company's warehouse at Wynona, Okla., has been transferred to a similar position for the company at Bartlesville. Elwood A. McKee, formerly chief clerk under Mr. Zimmerman at Wynona, has been made Wynona storekeeper.

R. C. Chamberlin

H. N. Blakeslee, who has been in charge of safety work in the petroleum section of the National Safety Council for several years, has been placed in charge of similar activities for the American Petroleum Institute. Mr. Blakeslee will move his headquarters to Dallas from Chicago. His experience in the oil business dates back to 1911.

H. N. Blakeslee

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John H. Baird has returned to service with the Byron Jackson Company after a leave of absence of approximately one year on account of illness. He is in charge of the company's export sales office at 1245 Graybar Building, New York City.

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J. D. Wyant will be in charge of operations at the plant of Espanola de Petroleos, Teneriffe, Canary Islands, until conditions at the plant have been worked out, when it will be turned over to its owners. The plant was built by the Bethlehem Steel Corporation and the C. D. Roberts Engineering Company for the Spanish Government. Mr. Wyant is scheduled to go to France upon the completion of his duties here to do similar work for the same companies at a refinery being built for the French Government.

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Dave Cowden, assistant purchasing agent, Arkansas Natural Gas Corporation, and Miss Mary Brown of Haynesville, La., were married early in October in a surprise wedding.

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Joe Wyatt of the American Cable Company, Houston, has returned from a trip to the Arkansas-Louisiana territory.

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Lee Croom, recently made acting storekeeper for the Indian Territory Illuminating Oil Company, has been made storekeeper.

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Neal Ammons, superintendent of tools for Cady-Connor-Crenshaw, Pampa, Texas, is now in charge of tool operations at Cushing, Okla.

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Will C. Barde, formerly chief electrician of drilling wells at Oklahoma City for Hall & Briscoe, is recuperating at Waurika, Okla., from an accident received some time ago.

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D. A. Sikes, with the California Talc Company, has moved to Oklahoma City and is making the Bridgeport Machine Store his headquarters.

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William Piez, European correspondent of the Link-Belt Company and a brother of Charles Piez, chairman of the board, Link-Belt Company, died at Brussels, Belgium, on November 2, after a week's illness. Mr. Piez was born at Newark, N. Y., in 1878. Previous to his association with the Link-Belt Company he was district manager of the Concrete Steel Company, Chicago. Since 1928 he lived at Paris, France, where he was European correspondent of the Link-Belt Company.

TIME *and* TROUBLE SAVERS

Where canvas slings are used in connection with a tractor to raise newly painted pipe, it is practice to throw a handful of dirt inside the sling to prevent it sticking to the coating and possibly pulling it off. Sometimes rocks and clods rupture the coating. On a major line it is practice to crumble the dirt before it is thrown inside the sling. By so doing the laborer discovers the rocks and clods and removes them.

In any concrete block acting as a foundation for heavy machinery such as a pump or engine, it always makes a neater job if that part of the block above floor level carries the original finish. To procure this end it is suggested that the form around that part above floor level be tapped with a light hammer. This causes the finer side of the mixture to thoroughly pack against the form and when the lumber is taken off the block will show a fine finish requiring no dressing. If the concrete has been tamped while pouring and the top of the form tapped the block will show up as a fine homogenous mass.

The use of various colored paint on the different lines and valves in a gasoline plant to distinguish water, steam, lean and fat oil, etc., has been successfully used for some time at the Latex plant of the Magnolia Gas Company.

The Ethyl Gasoline Corporation determines sulphur in gasoline by a volumetric method, which requires no weighing. The method is accurate and saves considerable time.

Rig band wheels and other equipment that protrude over the side of trucks can be hauled on the highway without the danger of side swiping another car by raising them above the top of passing cars. This may be done by placing timbers on the floor of the truck.

A handy rack for keeping rods from the dirt when they have been pulled is in use by the Comar Oil Company at Tonkawa, Okla. Old small diameter pipe has been used. A series of short upright posts, welded together by a cross-member in an "H" shape have been placed alongside the rig and the rods laid across these.

A good heating stove can be made out of an old oil drum by cutting away a portion of one side for an outlet. By running a gas line in and putting an old ball from a pumping ball and seat the flame may be thrown out over the inside of the drum, which will send the heat out over the room.

In the Deep Rock Oil Company's warehouse at Drumright an old tank ladder has been placed on the ceiling, and fastened to the rafters. This makes a fine rack for standing up short jointed pipes, conduits and polish rods.

A handy belt rack can be constructed by welding two upright pieces of pipe together with a cross-member. The cross-member acts as an axle for the roll of belting and any desired length can be unrolled and cut off.

A nail storage system that is quite handy and also clean is to place the kegs the nails come in into a frame box, which will tip outward for the convenient getting out of the nails. This way it is never necessary to remove the nails from one container to another, and each time a new keg is placed in the rack all of the old dirt that accumulates will be carried out in the old emptied keg.

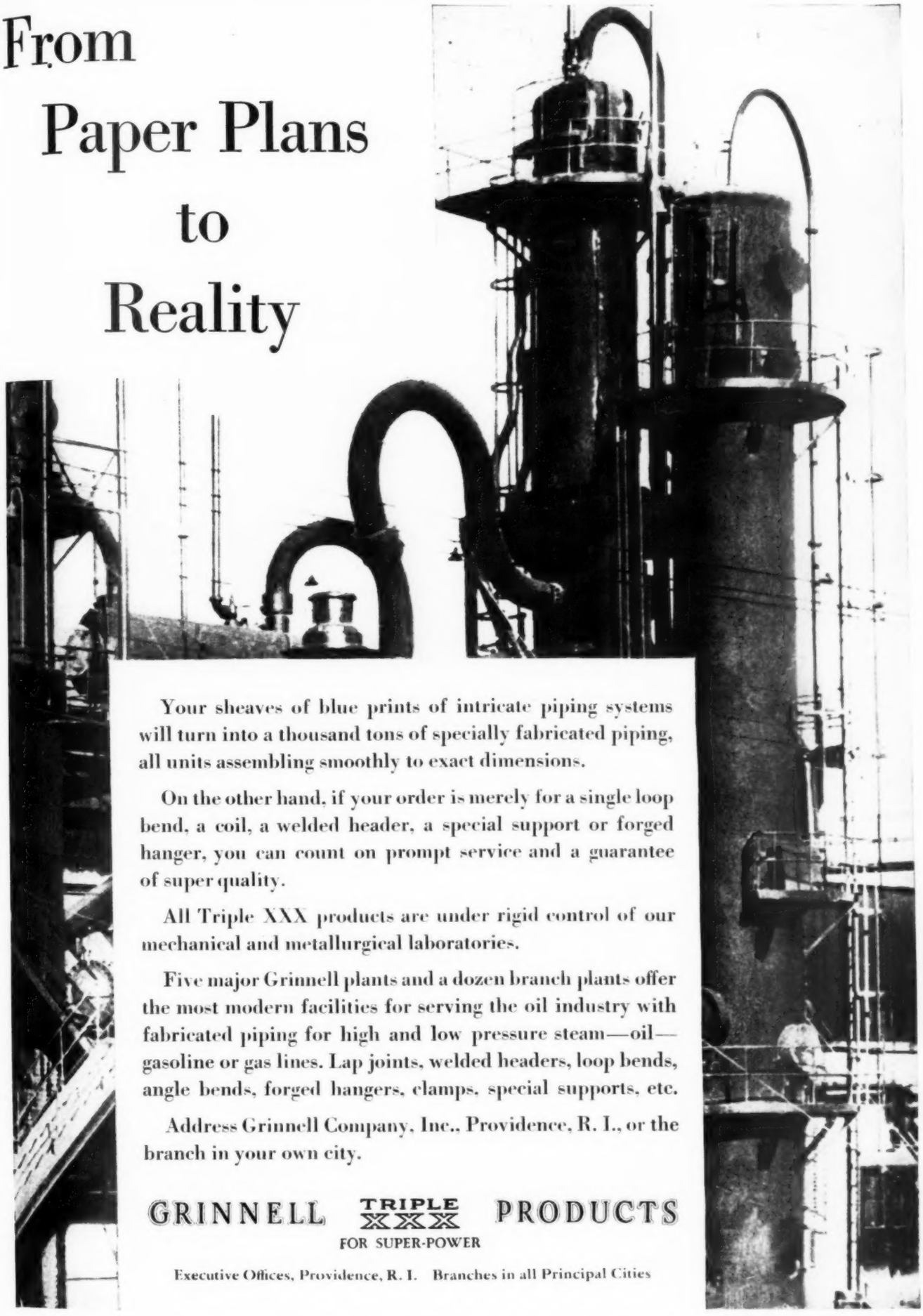
The frosting of high pressure regulators due to extreme pressure reductions on gas lines may best be remedied by the use of preheaters to raise the gas temperature several degrees before it enters the regulator.

When hauling tubing or rods it is a good practice to protect the threads from damage. This may be done by wrapping the threads in canvas or burlap. If soaked in oil these offer better protection.

Belts in service sometimes acquire a considerable static electric charge as a result of the fricture between the belt and the pulley. An effective and simple remedy for this is the placing of a conductor for carrying off the static charge from the belt. Such a conductor can be made from a piece of copper wire, one end of which is well-grounded to earth, the other placed close to the surface of the belt while running, usually just above the pulley.

It often happens that pipe connections have to be made up in a restricted space, and sometimes there is room for only one chain tong on the pipe or connection. By placing two chain tongs in the same plane on the connection, but 180 degrees apart, and placing the chain of one tong into the jaws of the other, the connection can be made up with much greater ease and without putting any undue strain on the other fittings.

From Paper Plans to Reality



Your sheaves of blue prints of intricate piping systems will turn into a thousand tons of specially fabricated piping, all units assembling smoothly to exact dimensions.

On the other hand, if your order is merely for a single loop bend, a coil, a welded header, a special support or forged hanger, you can count on prompt service and a guarantee of super quality.

All Triple XXX products are under rigid control of our mechanical and metallurgical laboratories.

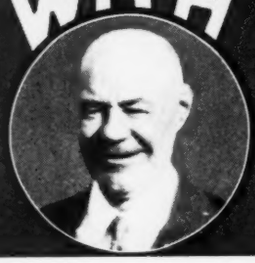
Five major Grinnell plants and a dozen branch plants offer the most modern facilities for serving the oil industry with fabricated piping for high and low pressure steam—oil—gasoline or gas lines. Lap joints, welded headers, loop bends, angle bends, forged hangers, clamps, special supports, etc.

Address Grinnell Company, Inc., Providence, R. I., or the branch in your own city.

GRINNELL TRIPLE XXX PRODUCTS
FOR SUPER-POWER

Executive Offices, Providence, R. I. Branches in all Principal Cities

LAUGH WITH BARNEY



Edited by **BARNEY HORRIGAN**

Barney Says

This is a land in which there is equality of opportunity, and if Coolidge had done differently he might have been as rich as Al Capone.

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The Modern Boy

The minister was visiting. "Let me hear how far you can count. Willie?"

"One, two, three, four, five, six, seven, eight, nine, ten, Jack, Queen, King."

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One of the lady tourists to a Western reservation was a human questionnaire, and at Inquiry No. 1000 even the long-suffering guide was losing his patience.

"Oh, tell me," she cried, "who is that great tall Indian standing by himself over there?"

"Madam," answered the weary guide, "that is Sitting Bull." He is on his vacation.

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Another of Those Laments

Oh, for the dear dread days that were and the times I used to know,
As I listened down in Finnegan's place to the tales of the long ago!
Of the plight of the traveling salesman shy who came to the crowded inn;
Of the cycling octogenarian; of the Methodist elder's sin.
Of the Scotchman's birthday present; of the piccolo player dumb;
Of the prosperous Irish immigrant and his refuse-collecting chum.
Of the clerk and the phonograph record, and many and many a more
That kept me aroar with laughter till my ribs were strained and sore.
Oh, take me back to the good old days when I listened with carefree brow.
To the gay lads telling the barroom jokes that my daughter tells me now!

Baron Ireland in Life.

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Sue: "See you had a date with an oil man."

Lu: "Nope. Tore my dress on a nail."

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Dad Was Willing

"I can't marry you," said the justice of the peace to the nervous bridegroom. "If this girl is only 17, you will have to get her father's consent."

"Consent!" yelled the groom. "Say, who do you think this old guy with the rifle is—Daniel Boone?"

— Liberty.

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She: What's your name
He: Juan.
She: Aw, go wan yourself!

Bill Skelly's Biggest Thrill

With the persistency characteristic of a Son of Erin, Barney Horrigan set out to find the most thrilling moment in the life of W. G. (Bill) Skelly, president of the oil company bearing his name. Barney knew it was not probable that his first producing oil well or any of the numerous honors bestowed on the popular oil leader would stand out in his mind as the greatest thrill, so he tacked off into the halcyon days of Bill's youth while the two had the smoking room of a Pullman to themselves.

It happened at a time when Bill was a printer's devil back in a small Penn. town and on the day of days in a small town —Circus Day. Circus Days in those days were real days because of nimble fingered jabbering short change artists who probably provoked Mr. Barnum's time tested observation anent suckers.

Bill was sent to collect a printing bill and after being shunted around for an hour he wound up before a cashier's cage with a bill loaded with so many okay's it appeared to be a leaf from an autograph book. The cashier spinning coins like a dervish made a grand gesture and shoved the money to Bill with a finality that completely hypnotized him as well as dared him to question the cashier's accuracy.

Later Bill discovered a shortage of $11.50. He knew, as every small town boy knows, that such murder would out and he would be the target of jokes for months. Too, his plans for entertaining that little girl on Elm street with a treat to the circus were shattered and there was the skipper of the printing establishment who might explode into a frenzy of anger.

With no alternative Bill wended his way back to the front office and admitted to the publisher, editor, manager, printer and what-not of the plant, he had been short changed.

"Congratulations," shouted the skipper. "I collected the bill myself last year and they short changed me $27.75."

Entirely Uncalled For

Banker (over phone): Mr. Cohen, your account is $3.65 overdrawn.

Mr. Cohen: That's strange. How did I stand a year ago?

Banker: You had a balance of $550.00.

Mr. Cohen: Well, did I call you?

—The Yellow Strand.

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A farmer out north of Robbinsdale came to town last week to have his eyes examined.

"Can you read that?" asked the optician, holding a card about 20 feet from his patient.

"Nope," replied the sod-buster.

The medico advanced 10 feet with the card and again put the question to the farmer. Again the farmer shook his head.

Becoming exasperated, the optician held it two feet in front of the farmer, who merely bit a chunk off his tobacco plug and shook his head.

"My gosh!" sighed the weary doc. "You must be blind!"

"Aw, it ain't that, doc," he drawled, "only I can't read."

—Whiz Bang.

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Its easy to entertain guests in the city because you can get plenty of food just by opening a can, and plenty of music just by opening a window.

—Life.

ƍ ƍ ƍ ƍ

"How old are you, little man?"

"Damned if I know, mister. Mother was twenty-six when I was born, but now she's only twenty-four."

—Washington Dirge.

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Bantam Car Driver (at filling station): "I want a glass of water for the radiator, a thimbleful of oil for the motor and a demi-tasse of gasoline—I think that'll be all—"

Station Attendant: "Could I cough in your tires?"

—From the show "Three's a Crowd."

ƍ ƍ ƍ ƍ

Mrs. Newlywed: "I'm sorry, dear, but dinner is a little burnt tonight."

Mr. Newlywed: "What? Did they have a fire at the delicatessen today?"

—Pathfinder.

ƍ ƍ ƍ ƍ

Suggestion

"What's the matter, dear?"

"Can't get this confounded self-starter to work. I think there must be a short circuit somewhere."

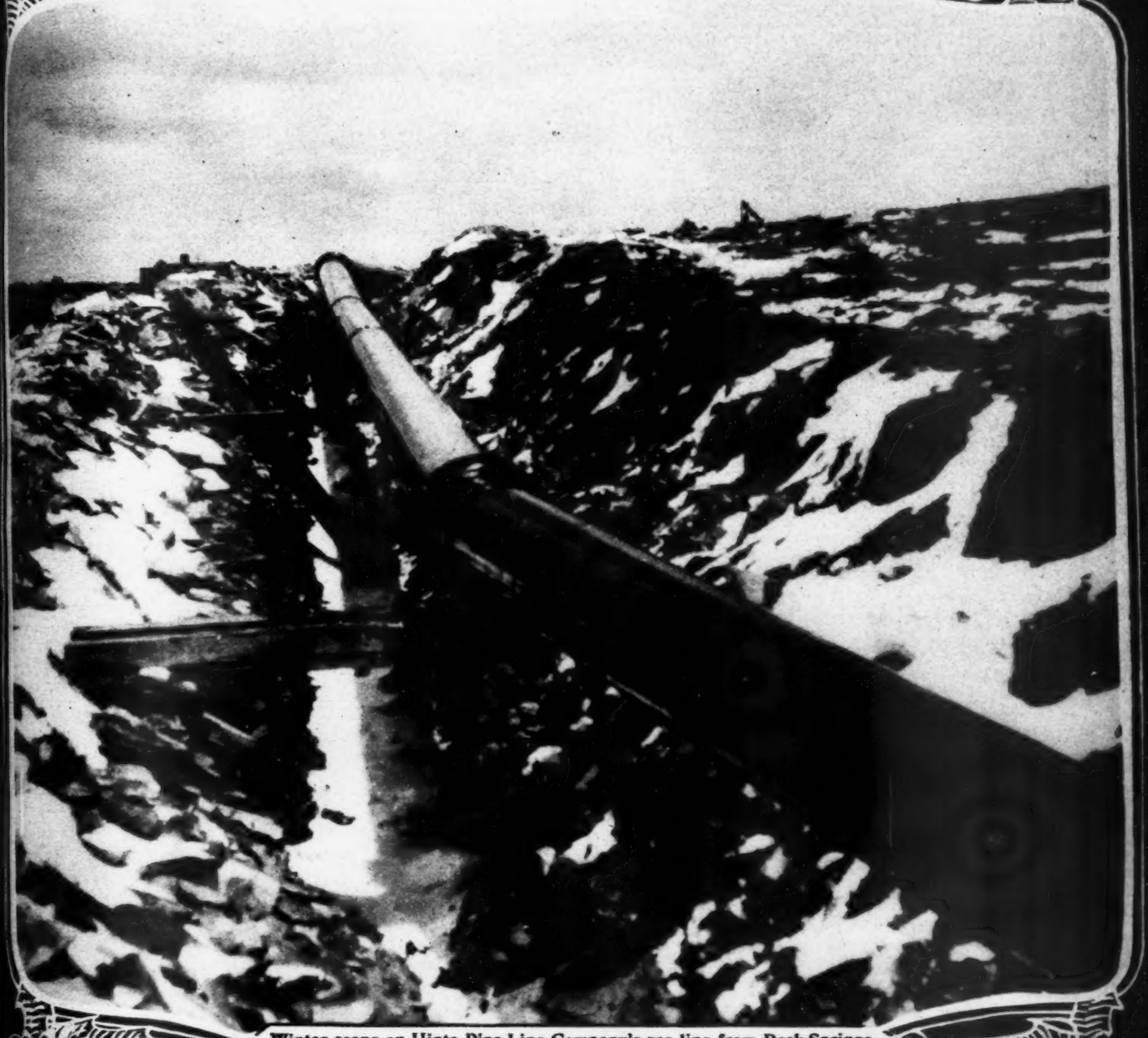
"How annoying! Can't you lengthen it?"

PICTORIAL PETROLEUM

MONTHLY ROTOGRAVURE FEATURE OF

The Petroleum Engineer

December 1930

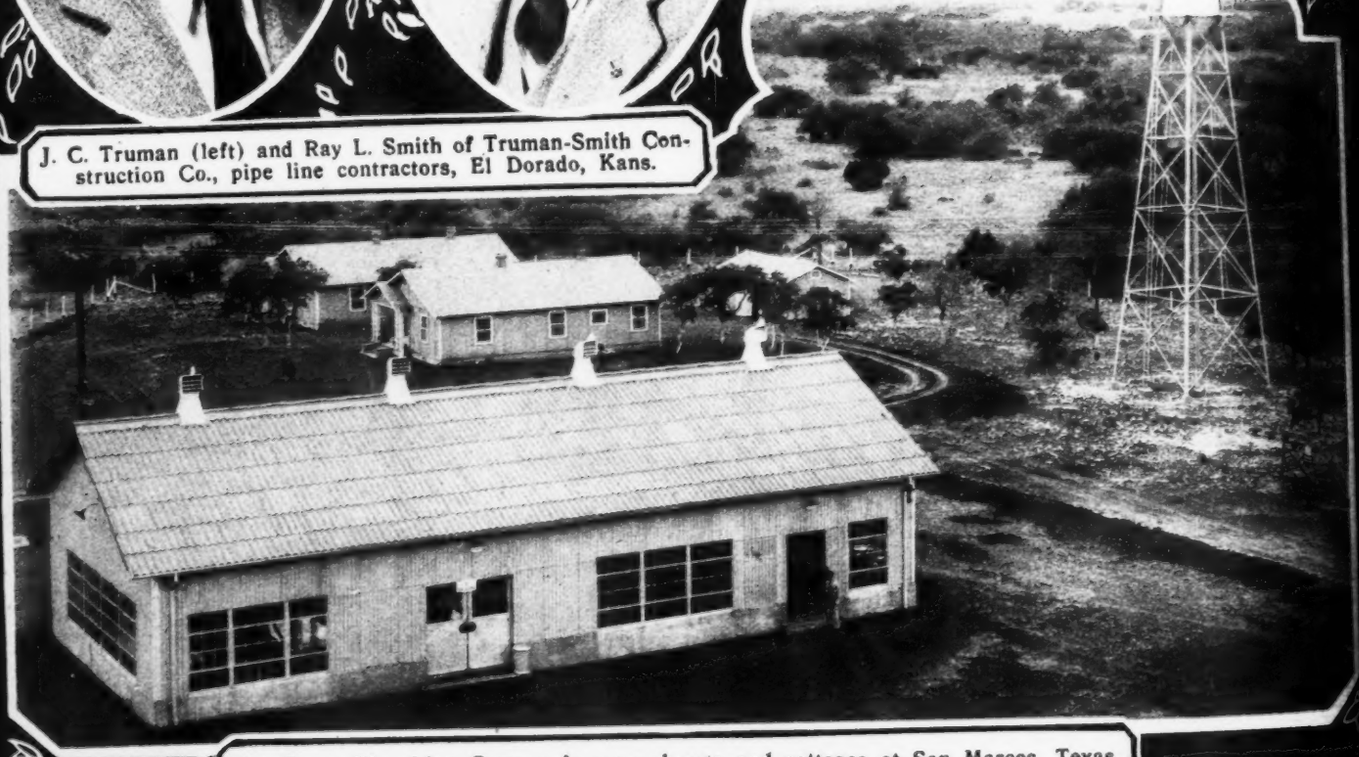


Winter scene on Uinta Pipe Line Company's gas line from Rock Springs, Wyo., to Salt Lake City.

Model PT 60 pipe line winch manufactured by Allsteel Products Mfg. Co., Wichita, Kans., handling 24-inch pipe on Missouri-Kansas Pipe Line Co. line near Newton, Kans. Williams Brothers were the contractors.

Above — L. D. Armstrong, manager, Gaso Pump & Burner Co., Tulsa, Okla. Left-E. R. Curry, Tulsa, Okla. district representative for Parsons Ditcher division of National Equipment Corp.

J. C. Truman (left) and Ray L. Smith of Truman-Smith Construction Co., pipe line contractors, El Dorado, Kans.



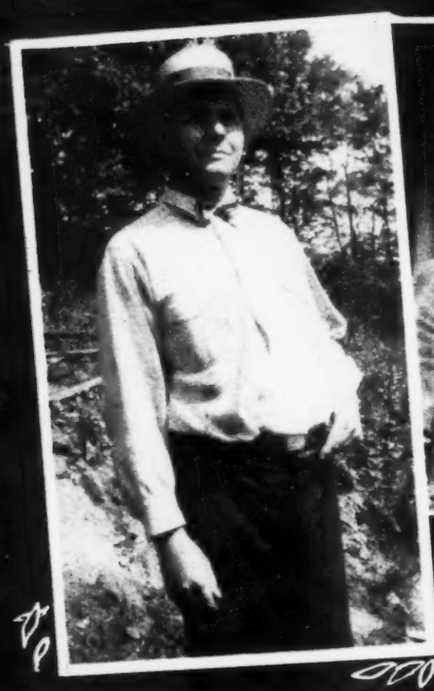
The Texas Pipe Line Company's pump house and cottages at San Marcos, Texas.

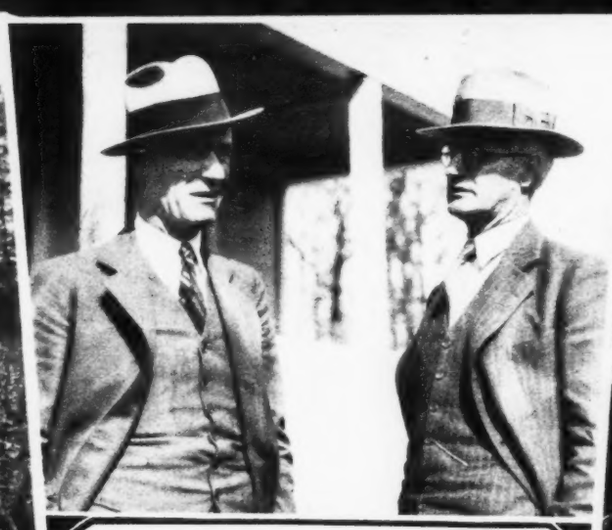
Fred Hays, Menominee, Mich., left, and Fred Thilenius, Tulsa, Okla., both with The Prescott Co.

Left—Noah E. Wagner, superintendent welding Prairie Pipe Line Co. Above—Trailer manufactured by Spencer Trailer Co., Augusta, Kans., in use in Oklahoma City field by Capitol Drilling Co. Right—R. S. Ellison, Tulsa, Okla., president Stanolind Crude Oil Purchasing Co. and Stanolind Pipe Line Co.

H. A. Wienecke, Tulsa, Okla., mechanical engineer Prairie Pipe Line Co.

Smith Brothers gang lining up pipe on section of The Texas Pipe Line Co.'s line from Sonora to Noxville in West Texas.

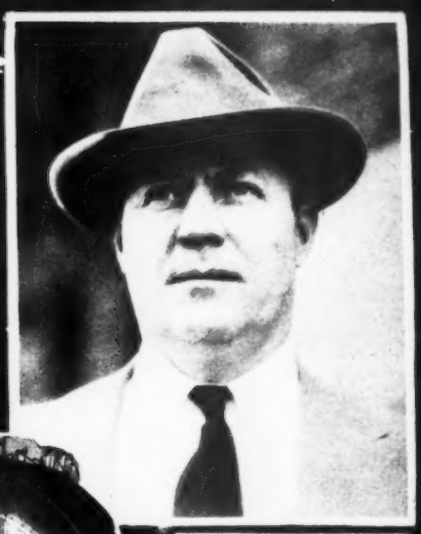




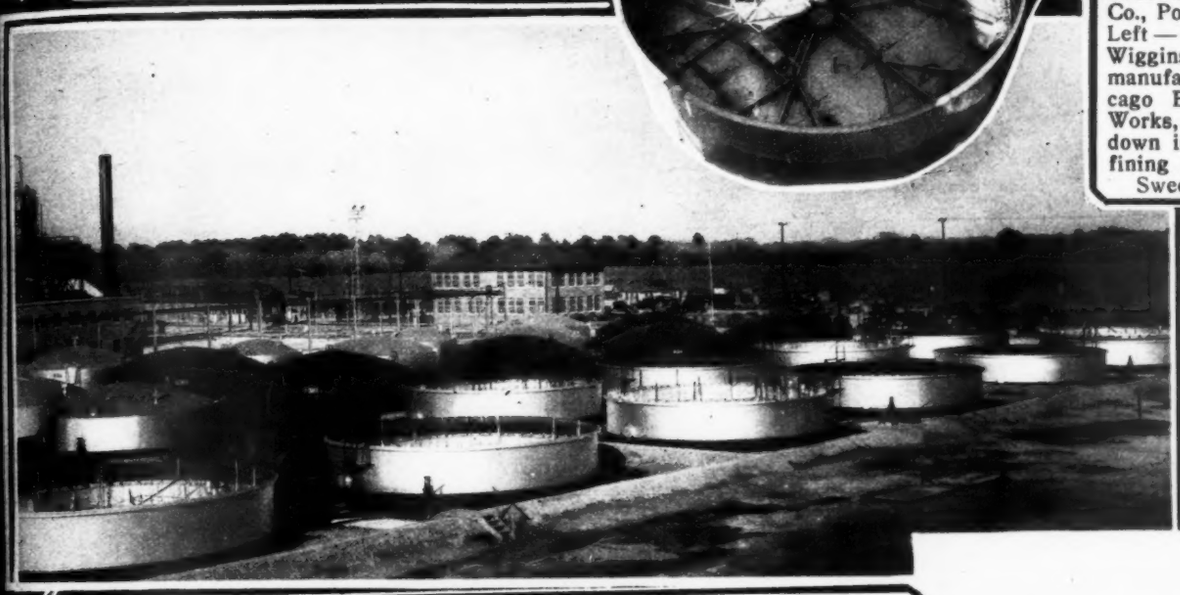
Left—H. K. Dougherty, general superintendent, Sloan & Zook, Bradford, Pa. Above—H. O. Helvie (left) assistant general superintendent and M. O. Stout, division superintendent, Carter Oil Co., Tulsa, Oklahoma. Right — "Dutch" Hayden, with Petroleum Equipment Co., Taft, Calif.

Above—Drilling crew of Mac & Stauffer Drilling Co. on Sinclair Oil & Gas Co.'s Morehouse No. 1, McPherson, Kans. They are using Chicago Pneumatic Tool Co.'s "Tucone" rock bit. The men are, left to right, John Wilhite, floor-man; Eddie Andrews, driller; A. R. Furmaw, derrick man; Tom Taylor, fireman; Henry Gardner, floorman. Left — H. Wirshing, with Waukesha Motor Co. Right—Clark Jenkins, Ft. Worth, Tex., salesman for C. F. Camp Co.

George T. Horton (right) president and Merle J. Trees, vice president, Chicago Bridge & Iron Works.



Above—F. E. Richardson, chief engineer, Great Lakes Pipe Line Co., Ponca City, Okla. Left — View showing Wiggins Floating Roof, manufactured by Chicago Bridge & Iron Works, lowered well down into a Gulf Refining Co. tank at Sweetwater, Tex.



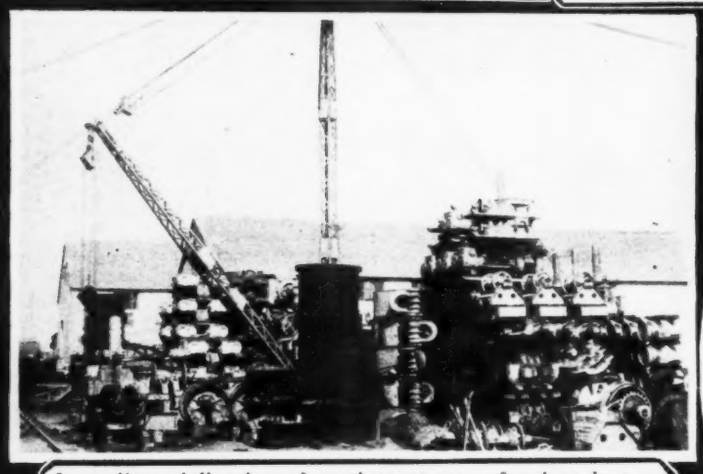
Ten rundown tanks at a Houston, Tex., refinery, each being equipped with a Wiggins Floating Roof.

The Hughes Tool Company's new $350,000 finished stock and shipping department building. This fireproof building is equipped with modern facilities such as mechanical refrigeration, steam heat, electric elevators, and a sprinkler system. It has a total floor area of 147,000 square feet.

R. J. Eiche of American Steel Export Company with a straight-eight roadster he won in a raffle. Mr. Eiche was last heard from in Port of Spain but now is likely to be in an even farther distant part of the world. His work takes him to practically every oil producing country and he enjoys a wide acquaintanceship in each of them.

C. O. Rison, superintendent of production, Indian Territory Illuminating Oil Co.

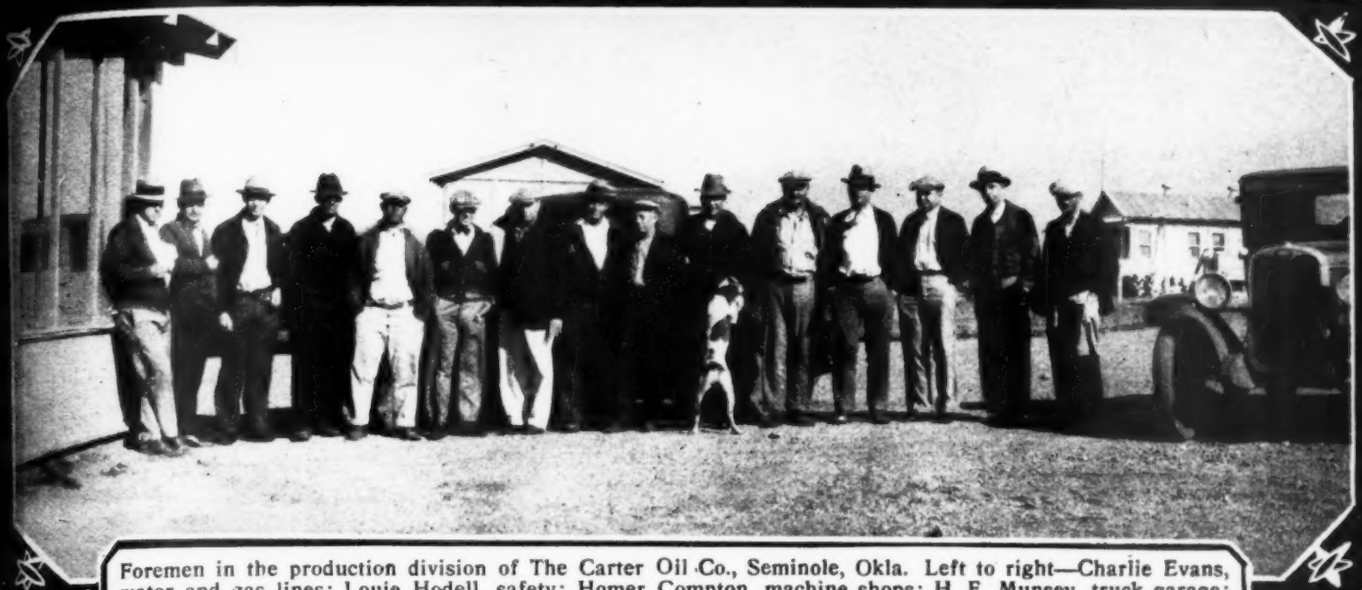
Left to right—J. S. Allaire, toolpusher; Lamar Jones, division engineer; W. L. Dean, driller; W. E. Hubbard, division superintendent all with Humble Oil & Refining Co. at Amarillo, Tex.; and Walter Trout, representative for Lufkin Foundry & Machine Co.



Immediate deliveries of equipment are of prime importance in the petroleum industry. The rotary tables, crown blocks, slush pumps, traveling blocks, wire line, etc., in the National Supply Co. yard at Oklahoma City are here set for quick loading on delivery trucks. Equipment shown is said to be worth close to $1,000,000.

Left—J. C. Fortune, sales engineer and, above, S. M. Decker, secretary, both with Sheldon Machinery Corp., New York City.

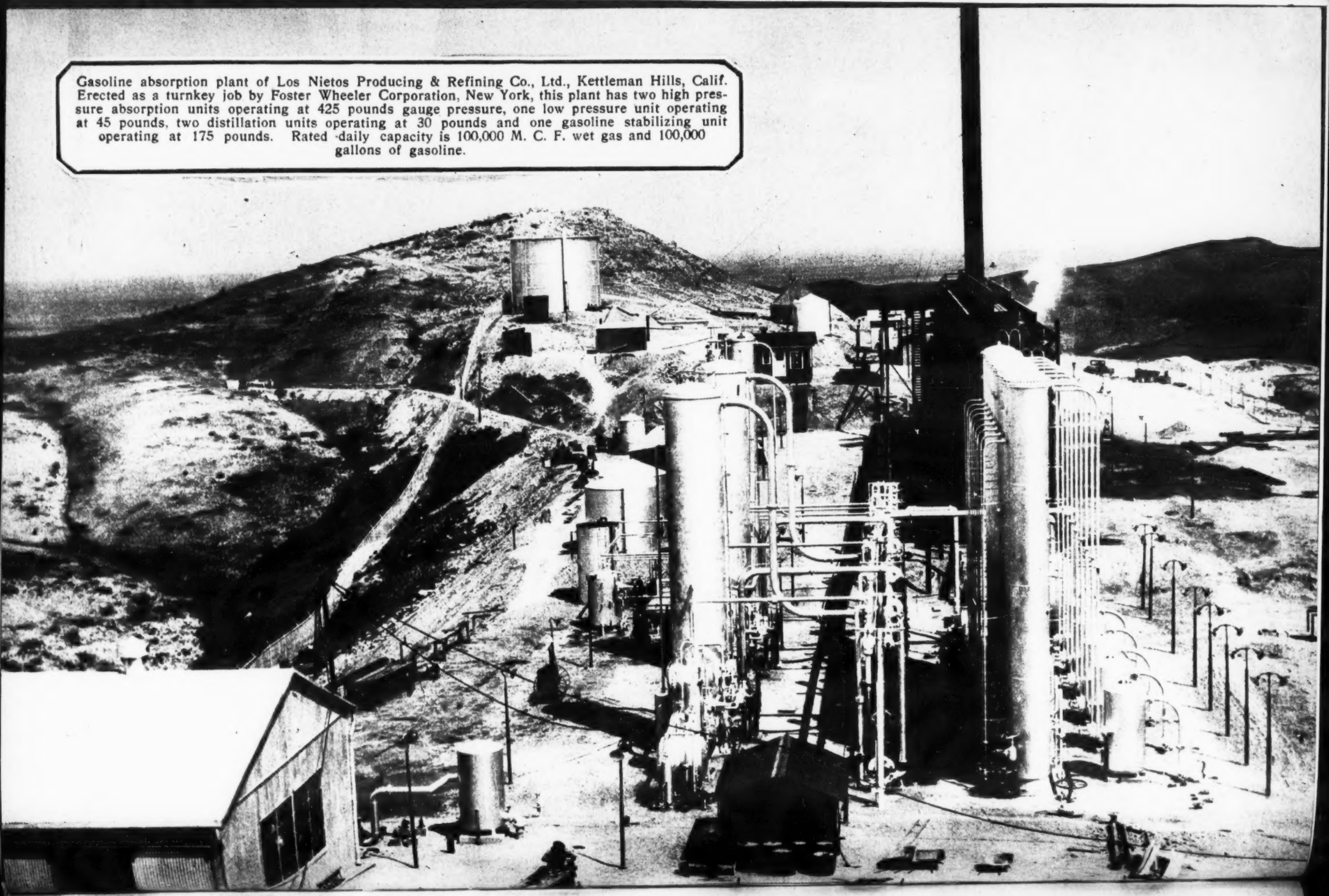
Five International Harvester Co. trucks loaded with 5,280 feet of 8¼" casing delivered to the Seminole field for Amerada Petroleum Corp. by A. C. Clark Transfer Co., Tulsa, Okla.



Foremen in the production division of The Carter Oil Co., Seminole, Okla. Left to right—Charlie Evans, water and gas lines; Louie Hodell, safety; Homer Compton, machine shops; H. E. Munsey, truck garage; O. D. Ramey, boilers; Bud Quillan, garage; Jack Millard, pipe lines; Homer Legan, general construction; George Donovan, water supply; Laurie Bowman, district foreman; Mac McCluny, construction; V. A. Pope, trucks; Ross McDougal, warehouse; "Doc" Cook, district clerk; A.F.Vincent, welding.

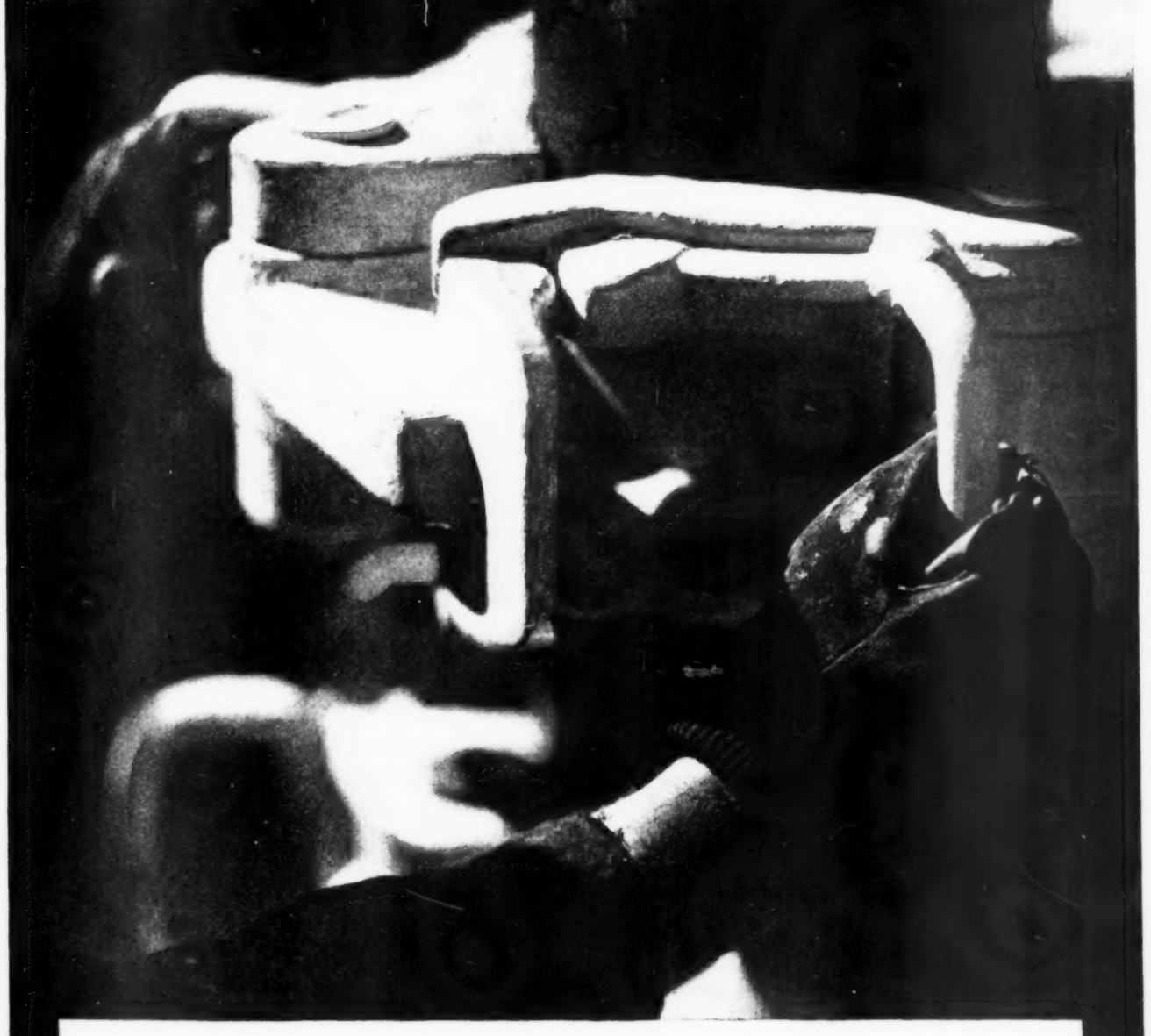
Production division farm foremen of The Carter Oil Co., Greater Seminole area. Left to right—Art Harmon, Little River; George Danner, assistant district foreman; "Heinie" Heintzleman, East Earlsboro and Carr City; Bert Coldren, Seminole; "Crook" Helvie, Bowlegs; Laurie Bowman, district foreman; "Buck" Buchanan, Cromwell; Paul Fleming, Saskawa; "Red" Armstrong, Cromwell; Claud McAfee, Bowlegs and Mission; "Speck" Feagins, Little River; Harry Alexander, Searight and Earlsboro; Jack Gribble, assistant district foreman, Cromwell.

Engineering and gas-lift division of The Carter Oil Co., Seminole. Left to right—Bob Conley, pumping equipment clerk; Kermit Kell, meters; Lem Norvell, gas measurements clerk; R. H. McPeake, assistant production engineer; Harold Shaner, production engineer; Fred Knight, chief clerk; Ray Kollar, production engineer; George Richardson, gas-lift foreman; George Levangie, assistant production engineer; "Happy" Crutcher, production engineer; F. W. (Rowdie) Robson, division production engineer, through whose courtesy photographs on this page are reproduced.



Gasoline absorption plant of Los Nietos Producing & Refining Co., Ltd., Kettleman Hills, Calif. Erected as a turnkey job by Foster Wheeler Corporation, New York, this plant has two high pressure absorption units operating at 425 pounds gauge pressure, one low pressure unit operating at 45 pounds, two distillation units operating at 30 pounds and one gasoline stabilizing unit operating at 175 pounds. Rated daily capacity is 100,000 M. C. F. wet gas and 100,000 gallons of gasoline.

BJ ROTARY TONGS
(WILSON TYPE)



THIS *grip* . . . like the handclasp of a lifelong friend . . . has inspired oil men for more than twenty years with a feeling of complete confidence.

BYRON JACKSON CO.

Established 1872

General Offices: 2150 East Slauson Avenue, Los Angeles, California

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215 East Archer Street, Tulsa, Oklahoma

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1245 Graybar Bldg., New York, N.Y.

When writing BYRON JACKSON CO. *please mention The Petroleum Engineer*

Buckeye's New Model 48

For the Largest Pipe Lines now Required

(6 Cutting Widths: 22" and 24"; 26" and 30"; 37" and 40". 3 Cutting Depths, 6½' 7½' and 8½')

SUCCESSFUL pipe-liners for over 30 years—that's Buckeye. Long and profitable performance has made them nationally known as "*the* ditchers that meet *all* oil and gas field trench requirements."

Following an established policy of constant improvement, Buckeye now offers powerful and speedy Model 48 for the biggest pipe line trenches. Its ruggedness is reinforced with remarkably easy control, favorite operating features and thorough ability to deliver a surprising amount of completed ditch at decidedly low cost. May we refer you to actual owners for evidence direct?

Model 48 automatically becomes leader in its field just as its smaller brothers are in theirs. That Buckeyes *are* the preferred standard of the pipe line industry is proven positively by three indisputable facts: *First*, more Buckeyes are engaged throughout the world's oil and gas fields than all other makes combined. *Second*, probably 95 per cent of all major American cross-country pipe lines are laid in Buckeye-cut ditches. *Third*, many large pipe line contractors use them exclusively, while others employ them in large numbers.

Write for our attractive new Catalog, "BUCKEYE —The Pipe Liner." It contains specification, mechanical and service details of decided interest to every prospective pipe line ditcher, owner and user.

The Buckeye Traction Ditcher Co.

FINDLAY, OHIO

There's a Buckeye Sales and Service Office near You

for over thirty years **Buckeye**

When writing THE BUCKEYE TRACTION DITCHER CO. *please mention The Petroleum Engineer*

661-Page Engineering Book Free

FOOTE BROS. Gear & Machine Co. of Chicago has published a 661-page book entitled "Gear Problems" which it is giving without cost or obligation to those in charge of the operation of machinery. This is a veritable reference work, cross indexed, and dealing with the subjects of speed reduction, gear operation and power transmission equipment. Anyone concerned with problems involving these subjects will find the book an invaluable aid. A copy may be had free by writing George J. Fix, representative, 2507 Commerce Street, Dallas, Texas.

Electrical Motors Bulletin

AN ATTRACTIVE eight-page printed bulletin covering The Louis Allis Company, Milwaukee, Wis., latest development in electrical motors—Type J, which marks an advance in the design of totally enclosed fan-cooled motors.

The outstanding features of the new motor are that it is tightly sealed, yet easy to take apart, therefore economical to install, operate and maintain.

Copies of this new bulletin may be secured by writing to The Louis Allis Company.

New Folder on Cavins Hydraulic Suction Bailer

A NEW folder describing the action and operation of the Cavins hydraulic suction bailer has recently been issued by the Cavins Bailer Service of 2750 Cherry Avenue, Long Beach, Calif.

This folder is the first of its kind ever to be written giving a detailed description of this bailer, which operates almost entirely by the fluid pressure of the well.

According to the manufacturers, this bailer is capable of removing sand, millings and miscellaneous fish from the bottom of the hole without spudding or any unnecessary loading operations. Furthermore, it loads in one second, dumps instantaneously, gets everything and permits no agitating sand.

Copies of the folder are being mailed out by the company and may be secured on request.

Attractive New Robinson Orifice Fittings Catalog

COMPLETION of an attractive new catalog containing the latest data and specifications concerning Robinson orifice fittings was announced recently by the Robinson Orifice Fitting Company of Los Angeles.

Although nearly 13,500 Robinson fittings are in use today and giving perfect service, company officials state, the refinement of certain details in construction made it necessary to issue the new catalog for reference by oil field and refinery engineers and all others concerned with pipe line maintenance and metering.

Working details of the different type Robinson fittings together with sizes, specifications and prices, are included in the book, as well as illustrations and description of the Robinson control valve.

Notes on Hydrogen Ion Measurements

LEEDS & NORTHRUP Company of Philadelphia, has issued a book entitled, "Notes on Hydrogen Ion Measurements." The specific purpose of the book is to furnish information that will be helpful to the large and rapidly increasing number of individuals interested in measuring the acidity and alkalinity of water solutions by electrical methods. The scope of the publication is indicated by the following list of topics discussed: "Meaning of Hydrogen Ion Concentration and pH Valve"; "Electrometric Hydrogen Ion Measurements"; "Hydrogen Electrode"; "Calomel Electrode"; "Potentiometer Principle"; "Assembly for Hydrogen Ion Measurements"; "Quinhydrone Electrode," and "Quinhydrone pH Indicator."

The major portion of the text is devoted to a description of apparatus employed for measuring hydrogen ion concentration or pH. It tells not only what the apparatus is, but how it is used and what its limitations are. Fundamental principles are also briefly discussed.

Remote Manual Control System

Bulletin No. 7520 of the Brown Instrument Company, Philadelphia, Pa., describes the de Florez System of manual control at a distance without mechanical transmission. This system is said to make any distant valve manually operable from a central point.

Latest Miller Sand Pump Pamphlet

THE Miller Sand Pump Company of Sapulpa, Okla., has just published a new pamphlet that lists all prices and parts of the company's various products. Copies of this pamphlet may be secured by request from the company.

Products listed include the Miller sand pumps, the Chancellor separator for installation below the working barrel, and the Jiffy Clamps for stopping leaks in water, gas or steam lines.

Johnston Manufacturing Company Catalog Sheets

TWO new catalog sheets, No. 551 and 605A, illustrating the Johnston reverse blast low pressure burner and new silent type direct connected pressure blowers.

The reverse blast burner atomizes by impact and mixes by violent ring rolling action. This powerful atomizing and mixing makes it possible to use the lower-priced, heavy, viscuous fuels with this burner.

Combustible Gas Indicator Booklet

THE Union Carbide Company, with offices in all of the largest cities of the United States, has published a booklet describing the purpose and operation of its U. C. C. methane indicating detector.

This detector is used for the detection and measurement of various combustible gases and vapors, such as firedamp, etc., in coal mines and oil refineries. It consists of a detector head, meter and battery.

The indicator is light enough to permit easy carriage to any point and the meter scale is always in range of the operator's eyes. An ample length of cable assures easy manipulation of the head in all parts of oil tanks, manholes, around pumps, etc. After setting the control switch and adjusting the meter needle to zero the head, containing the sensitive detecting element, is simply placed in the suspected atmosphere. If gas is present it causes the needle to move up the scale.

Further information and literature may be obtained from any of the Union Carbide Company offices. Headquarters for the company are in New York City.

It's Safe *with an* Emergency Pipe Clamp

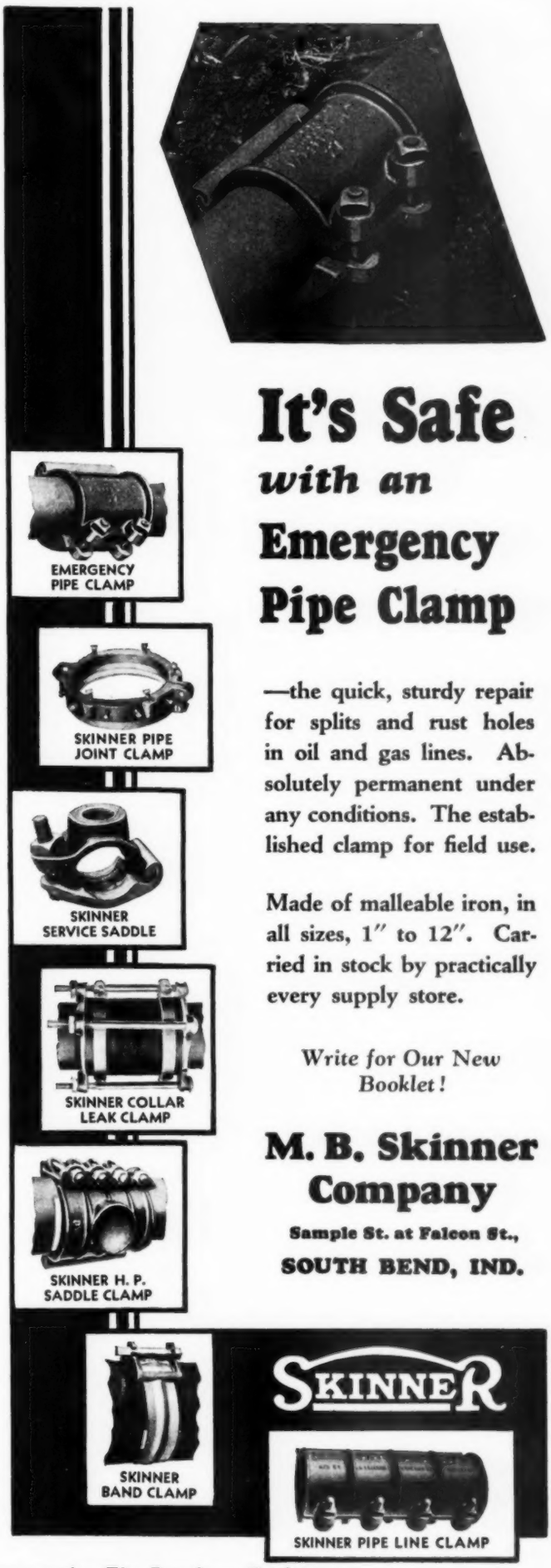
—the quick, sturdy repair for splits and rust holes in oil and gas lines. Absolutely permanent under any conditions. The established clamp for field use.

Made of malleable iron, in all sizes, 1″ to 12″. Carried in stock by practically every supply store.

Write for Our New Booklet!

M. B. Skinner Company

Sample St. at Falcon St.,
SOUTH BEND, IND.



When writing M. B. Skinner Co. *please mention The Petroleum Engineer*

It is significant that the major portion of Oil Produced in Seminole Area is pumped away to Refineries or Main Pipe Line Stations with ELECTRIC MOTOR driven PUMPS.....

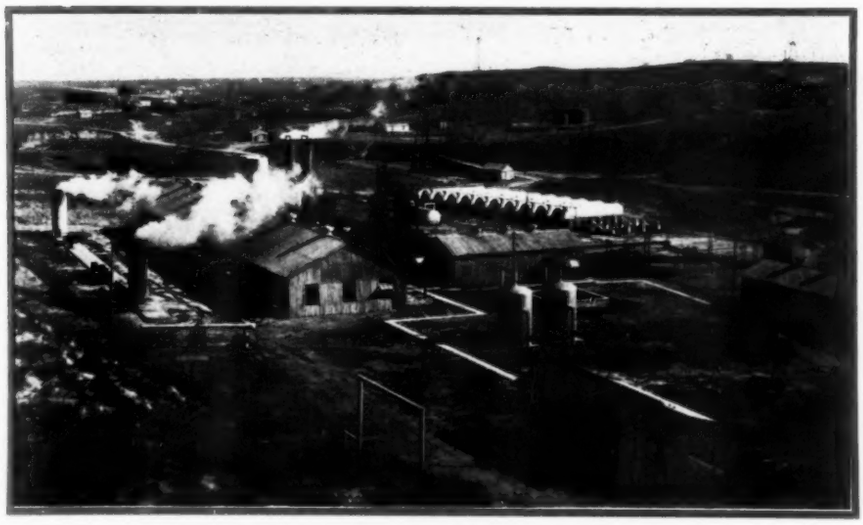
Commercial Department

OKLAHOMA GAS AND ELECTRIC COMPANY

J. F. Owens, Vice-President and General Manager
Courteous Personal Attention to Every Customer.

Oklahoma City, Okla.

When writing Oklahoma Gas & Electric Co. *please mention The Petroleum Engineer*



Wilcox Oil and Gas Company natural gasoline plant, Pampa, Texas.

TREATING LIGHT OILS

By G. STAUB, *Refinery Engineer, Phillips Petroleum Co. Bartlesville, Okla.*

THE color and odor, as well as the distillation range, play an important part in the gasoline market. The gasoline must meet certain specifications and must not contain more than a certain amount of sulphur. Nearly all petroleum oils contain sulphur in various forms, either as free sulphur or in form of organic sulphur compounds. Some of this sulphur has to be treated out. As a consequence of producing gasoline from a great variety of crudes, either as straight run or cracked, the gasolines require different methods of treating. The gasolines from each different source present an individual problem in treatment and definite rules cannot be laid down.

Beyond certain limits the presence of sulphur in oil is objectionable. Certain types of sulphur compounds are objectionable, even in traces, on account of bad odor, corrosive action and unstability of color. Some of these objectionable sulphur compounds can be eliminated by mixing and treating the gasolines with chemicals. These operations are known under the name of

Oil Sweetening.

The most objectionable sulphur compounds contained in the gasolines, naphthas and kerosenes and which will be treated out chemically or changed into different compounds are:

1. Free sulphur, S.
2. Hydrogen sulphide, H_2S or H-S-H.
3. Organic sulphides, R-S-R.
4. Mercaptans, R-S-H.
5. Disulphides, R-S-S-R.
6. Thiophenes, C_4H_4S.

There are some other sulphur compounds present in most oils, but these do not affect the quality of the oils and are not considered in this article.

Properties of Organic Sulphur Compounds.

1. *Hydrogen Sulphide*, H_2S or H-S-H.

This compound is found in nearly all crude oils, especially in the heavy crudes. Its boiling point is very low, so during the distillation of crude oils containing hydrogen sulphides large quantities of the compound pass off as gas, while the remainder will distill over with the light oil fractions. H_2S in the presence of water has weak acid properties. This acid is very corrosive and acts on the condensers, run-down lines and tanks. The corrosive action can be prevented by the introduction of ammonia, NH_3, or caustic soda, NaOH, into the condenser coils and pipe lines.

2. *Mercaptans or Thio Alcohols* "R-S-H"

may be considered as sulphur compounds in which one hydrogen atom in the hydrogen sulphide molecule is replaced by one alkyl radical "R." For example:

Ethyl mercaptans C_2H_5—S—H = R-S-H, in which Ethyl radical R = C_2H_5. The mercaptans react with sulphuric acid H_2SO_4 to form soluble—disulphides = R-S-S-R—and with the doctor or sodium plumbite, Na_2PbO_2, they form *lead mercaptides* = RS-Pb-S-R. This reaction with the doctor solution takes place in two phases:

1. $2\,(R\text{-}S\text{-}H) + PbO \longrightarrow \begin{matrix} RS \\ RS \end{matrix} > Pb + H_2O$

2. $2\,(R\text{-}S\text{-}H) + Na_2\,PbO_2 \longrightarrow \begin{matrix} RS \\ RS \end{matrix} > Pb + 2\,NaOH$

The lead mercaptides are soluble in the gasoline. There are two other reactions possible with the mercaptans:

1. $\begin{matrix} R\text{-}S \\ R\text{-}S \end{matrix} > -Pb + S \longrightarrow \begin{matrix} R\text{-}S \\ \vert \\ R\text{-}S \end{matrix} + PbS$

2. $2\,(R\text{-}S\text{-}H) + 2\,NaOH + S \longrightarrow (R\text{-}S\text{-}S\text{-}R) + Na_2S + H_2O$

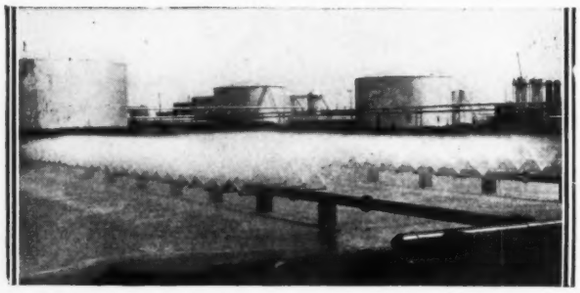
Explanations:

PbO = Litharge
Na_2PbO_2 = Sodium Plumbite
NaOH = Sodium Hydroxide
$(R\text{-}S)_2Pb$ = Lead Mercaptide

The mercaptans are the principal sulphur compounds that cause the gasoline to be sour. There are a great variety of mercaptans and roughly they may be classified into lower and higher mercaptans, according to the molecular structure of the radicals R.

3. *Organic Sulphides or Alkyl Sulphides.*

These sulphides, which are also called sulphur ethers, are formed by replacing the two "H" atoms of the hydrogen sulphide molecule H-S-H by two alkyl radicals "R," which



A Marley spray pond in use by one of America's largest companies.

Maximum Cooling Efficiency with Marley Cooling Equipment . . .

MARLEY water-cooling systems provide the three essentials of water-cooling efficiency—pumping economy, thorough water break-up and entire freedom from clogging.

This balanced performance accounts for Marley economy and assures maximum cooling efficiency.

Before you install new systems or enlarge or improve old ones, it will pay you to investigate the Marley line.

SPRAY NOZZLES—SPRAY PONDS—SPRAY TOWERS
DECK TOWERS—LOUVRE FENCES AND
ALL ACCESSORIES

Marley Patented Spray Nozzles

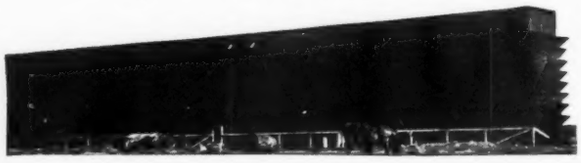
Marley non-clog spray nozzles provide a fine, uniform spray at low pressures because of their simple design and large free passages. These nozzles are a part of all Marley installations and can also be used to greatly improve the efficiency of other cooling systems.

Full Information Upon Request

THE MARLEY CO.

1737 Walnut **Kansas City, Mo.**

Representatives in Principal Cities



Marley Deck Type Tower of 7,000 gallons capacity.

reaction gives the formula: R-S-R. For instance the structural formula for

Ethyl Sulphide is $C_2H_5 - S - C_2H_5 = R\text{-}S\text{-}R$
Ethyl Radical $R - C_2H_5$

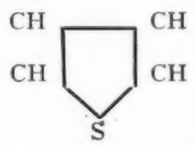
These sulphides may also be regarded as thio-ethers. There is no reaction between the organic sulphides R-S-R and the sodium plumbite (Doctor) Na_2PbO_2.

4. *Disulphides or Alkyl Disulphides,* R-S-S-R.

There is no reaction with the Doctor solution. Concentrated sulphuric acid H_2SO_4 will dissolve these compounds fairly well. Disulphides are soluble in oils and therefore they go back into the oils when left in contact with them.

5. *Thiophene,* C_4H_4S.

This is a closed chain of hydrocarbon compounds having the structural formula:



Thiophene does not react with the Doctor Na_2PbO_2, but will dissolve in sulphuric acid with which it will form.

Thiophene Sulphonic Acid, $C_4H_3S - SO_2 - OH + H_2O$.

Thiophenes may be detected by shaking the gasoline with sulphuric acid and "Isatin," which is an oxidation product of indigo. If thiophenes are present, the product acid assumes then a beautiful blue color. Thiophenes resembles benzine very closely in chemical and physical properties.

Chemistry of Sweetening.

Sourness of an oil is defined as the presence of organic sulphur compounds in the oil, which give a positive Doctor test, according to the standard test procedure.

Sweetening is the removal of these compounds which render the oil sweet and giving a negative Doctor test.

It is therefore necessary to know what the Doctor test is and how the Doctor solution is prepared.

Doctor Solution is prepared by making a strong 16°B caustic solution (sodium hydroxide NaOH — water and adding a certain amount of litharge). The caustic will react with the litharge and form a solution of sodium plumbite — Na_2PbO_2, which is called Doctor solution 2 NaOH plus PbO = Na_2PbO_2 plus H_2O. The additions of litharge raises the gravity about 2 degrees Beaume.

Doctor Test—In making the Doctor test on gasoline and kerosene, one part Doctor solution and two parts gasoline are vigorously, for 15 seconds, shaken together in a 4-ounce bottle. Then a small pinch of flowers of sulphur is added and shaken again vigorously for fifteen seconds and allowed to settle. The quantity of sulphur used must be just enough so that practically all of it floats on the interface between the gasoline and sodium plumbite solution. If the gasoline sample is getting discolored or the sulphur film color is noticeably changed, then the test shall be reported as positive and the gasoline or kerosene be condemned as sour. If the sulphur color remains bright yellow then the sample is reported as negative, and the oil is considered to be sweet.

The sourness of gasoline (and kerosene) is principally caused by

a. Hydrogen sulphide, H_2S,
b. Alkyl mercaptans, R-S-H,

and the purpose of treating is the removal of these two groups of sulphur compounds. During the treating process a number of chemical changes are taking place which will be considered under the following treating methods.

Refinery Practice.

There are a number of chemicals with which the gaso-

lines can be treated sweet. The selection of the chemical for treating depends on the sulphur contents of the oil and on the costs of chemicals and processing. In most cases it has been found that the caustic soda wash and Doctor treat are giving satisfactory results for sweetening gasolines at the cheapest manufacturing costs.

Gasolines from sweet crudes require usually no acid treatment.

Gasolines from heavy crudes, having a high sulphur content, require much longer treatments, using more chemicals and an additional acid treatment when it becomes necessary to reduce the sulphur contents in the finished product.

Treatment of Oils with Low Sulphur Contents.

In regular refinery practice the gasoline is first given an

A. *Caustic wash*

for removing the hydrogen sulphide. The strength of the caustic solution varies between 20 and 25 degrees Beaume. The chemical reaction taking place during this caustic treatment is the

Neutralization of sodium hydroxide NaOH by the hydrogen sulphide H_2S and forming a reaction product sodium sulphide $Na_2S + H_2O$

The sodium sulphide is entirely insoluble in oil and can be removed by washing with water.

Result: The sulphur contained in H_2S is eliminated from the oil. Then the gasoline is treated with a

B. *Doctor or sodium plumbite solution,*

20-25 degrees Beaume gravity, for the removal of the lower mercaptans. In contact with the sodium plumbite, Na_2PbO_2, the alkyl mercaptans, R-S-H, contained in the gasoline undergo a chemical change and turn into

Lead mercaptides, R-S-Pb-S-R:

$$2\,(RSH) + PbO \longrightarrow R\text{-}S\text{-}Pb\text{-}S\text{-}R + H_2O$$

$$2\,(RSH) + Na_2PbO_2 \longrightarrow R\text{-}S\text{-}Pb\text{-}S\text{-}R + 2\,NaOH$$

The lead mercaptides have the following properties:

a. Some remain entirely in the gasoline if the concentration is not above a certain limit.

b. The lower mercaptides are less soluble in gasoline than the higher ones.

c. The higher mercaptans insoluble in water and hence react very slowly with the sodium plumbite to form the lead mercaptides. For this reason a gasoline which contains much high mercaptans takes a very long time to sweeten.

Then when free sulphur is added to the gasoline, the lead mercaptides are converted into disulphides, R-S-S-R, and lead sulphides, Pbs:

$$\begin{matrix} R\text{-}S \\ R\text{-}S \end{matrix} > -Pb + S \longrightarrow \begin{matrix} R\text{-}S \\ | \\ R\text{-}S \end{matrix} + Pbs$$

The lead sulphide, formed after the sulphur "S" is added to the lead mercaptides, precipitates as a black sludge.

The immediate affect of the Doctor solution on the oil is to discolor same. The alkyl mercaptans react with the Doctor solution and form a yellow solution, the lead mercaptide. If there is hydrogen sulphide present the yellow color cannot be seen, the black lead sulphide entirely hiding the yellow color of the mercaptides.

$$2\,RSH + Na2PbO_2 \longrightarrow R\text{-}S\text{-}Pb\text{-}S\text{-}R + 2\,NaOH$$

Alkyl mercaptans plus sodium plumbite ——— Lead mercaptide and caustic. The yellow solution of lead mercaptide on standing in air gradually turns black, due to general oxidation by sulphur dissolved in the oil and in treating this reaction is accelerated by the addition of free elementary sulphur.

$$R\text{-}S\text{-}Pb\text{-}S\text{-}R + S \longrightarrow R\text{-}S\text{-}S\text{-}R + PbS$$

The lead mercaptides are oxydized to

Alkyl-disulphides, R-S-S-R,

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this new ACME Piston Valve type

Heavy Duty Slush Pump

15" x 7¼" x 18"

✓ capacity
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which are soluble in gasoline and do not react with sodium plumbite, the reaction being

$$R\text{-}S\text{-}Pb\text{-}S\text{-}R + S \longrightarrow R\text{-}S\text{-}S\text{-}R + PbS$$

Lead mercaptides plus sulphur ——— Alkyl disulphides + Lead sulphide.

The alkyl disulphides formed in the above reaction are soluble in the oil and therefore go back into solution and the lead sulphide settles out. From the above reactions it can be seen that sweetening has removed no sulphur from the oil, but merely converted it into a different compound which does not react with sodium plumbite, Na_2PbO_2, and is not corrosive.

When free sulphur is added in sweetening care must be taken not to use excessive amounts, as it is soluble in gasoline and kerosene and will tend to increase the percentage of sulphur contents and at the same time tend to have a corrosive effect on copper with which it may come in contact. To determine and control, if excessive elementary sulphur is used, the copper strip test is made. If excessive quantities of free sulphur are used it will turn the copper black or show signs of discoloration.

The heavier mercaptans have to be treated out with sulphuric acid.

Action of Lead Sulphide in Sludge Doctor

Note. — Sludge Doctor is the name for Doctor solution already used for gasoline treatment.

Result: The sulphur contents of the mercaptans is not removed from the oil by the Doctor treatment, but changed into different sulphur compounds which do not affect the Doctor test.

The reaction of the higher mercaptans in kerosene is identical to those in the gasoline, except that the reaction is incomplete as some of the very heavy mercaptans do not react with the sodium plumbite.

In sweetening pressure kerosene with sludge doctor, the kerosene was not darkened in color, and in many cases was improved in color and a very stable product was made. The use of new doctor in sweetening kerosene causes a loss in color and an unstable product.

To explain the above conditions, the lead sulphide found in the sludge doctor is a very porous substance, and its action is purely catalytic and no chemical reaction takes place between the mercaptans and the lead sulphide. The surface exposed is easily wetted by the oil and serves to absorb the sulphur compounds, especially mercaptans, and does not take part in the sweetening reaction, but it is of assistance in sweetening by acting catalytically to absorb the mercaptans on its surface and to enable them to react with the lead in the sodium plumbite solution and sulphur.

As we know that the reaction between heavy mercaptans and sodium plumbite is not complete, it is possible that the heavy mercaptans in kerosene, which do not react with sodium plumbite, are absorbed to the surface of the lead sulphide and there react with the lead and sulphur, this way making a more stable product by the changing of the heavy mercaptans in disulphides, but its catalytic effect making a product much more permanent than one sweetened with new doctor and sulphur.

Assuming that the reaction between sodium plumbite and heavy mercaptans is not complete, then if a very small quantity of mercaptan is converted to lead mercaptide and not oxidized to disulphide, it would be possible that this small quantity of lead mercaptide is the cause of loss of color in using new doctor solution.

For the additional reduction of the sulphur contents, the oils require a

Sulphuric Acid Treatment

Some of the gasolines having a high natural sulphur content and many kerosenes have to be treated with sulphuric acid, H_2SO_4 of 66 degrees Beaume strength. These treatments will decrease the sulphur content, but increase also the losses.

The chemical processes taking place in the acid treatments are very complicated and very little is known about the many individual reactions during these operations.

When concentrated sulphuric acid reacts with petroleum products, a number of reactions do occur, both physical and chemical.

The most important reactions by the sulphuric acid are—

Desulphurization—(Decomposition of mercaptides)
Solvent action

Sulfonation.

Addition.

Polymerization, tendency to raise the endpoint.

Formation of secondary and tertiary alcohols.

Sulphuric acid, 66 degrees Beaume, oxidizes mercaptans, R-S-H, to disulphides with evolution of SO_2.

Disulphides, R-S-S-R, first formed may produce thiosulfonic ester, R-S-SO_2-R, which dissolves in gasoline and sulphuric acid.

Desulphurizing effect on alkyl sulphides.

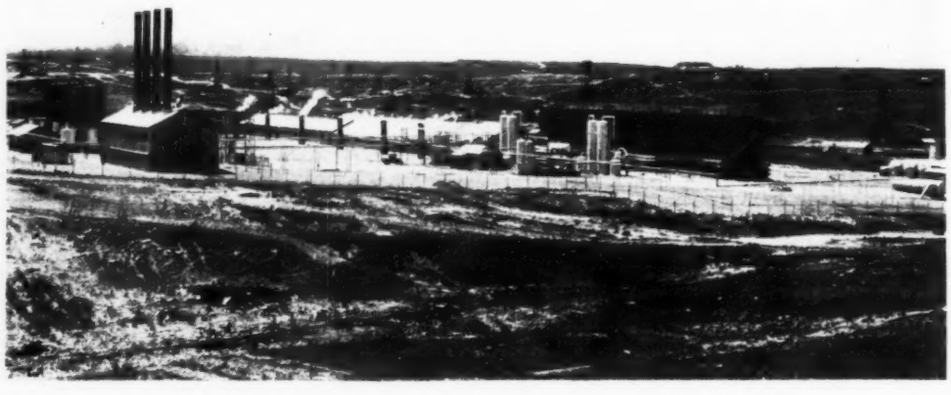
Desulphurizing effect on disulphides.

Desulphurizing of thiopenes to thiopene sulfonic acids—

$$C_4H_4S + HO\ SO_2OH = C_4H_3S\text{—}SO_2\text{—}OH + H_2O$$
$$(H_2SO_4)$$

The sulfonic acids can be washed out with water and alkali and they are also absorbed by Fuller's earth.

When polymerization occurs, the polymers formed are likely to dissolve in the gasoline instead of in the acid, thus raising the endpoint of the product. Hence the desir-



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DOWN!

DOWN!

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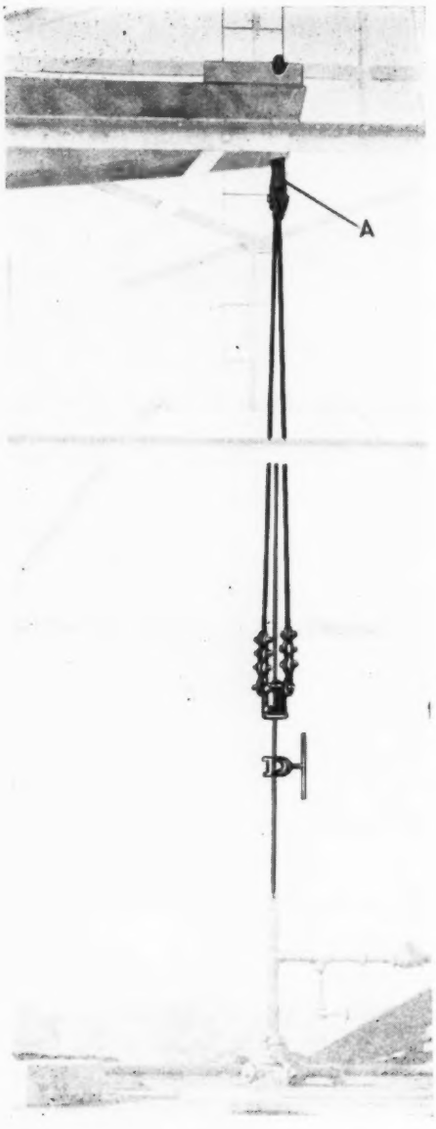

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The above view shows the No. 1 Ratigan Beam Hanger (A) on a standard wood beam. It is equipped with No. 6 Ratigan Grip, No. 6-5 Wire Line Clamps and No. 2 Ratigan Polish Rod Clamp. Hanger Stem is of heavy "I" Beam construction. This is an ideal combination for wells where a straight lift hanger is not required. Bulletin No. 12 gives full details—write for it.

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ability of acid treatment before the final distillation is made, especially in the case of cracked gasolines.

Cupric Chloride Treatment of Light Oils.

For the removal of hydrogen sulphide, H_2S, and the lower mercaptans, R-S-H, contained in the gasoline, it is washed with a 20-degree Beaume caustic soda solution, NaOH (sodium-hydroxide). The chemical reactions taking place are:

1. For hydrogen sulphide—

$$H_2S + NaOH = NaSH + H_2O$$

that is the neutralization of sodium hydroxide, NaOH, by the hydrogen sulphide, H_2S, with the formation of the reaction product, NaSH, sodium hydro-sulphide and water.

2. For the lower mercaptans, R-S-H—

$$(R\text{-}S\text{-}H) + NaOH = (RS) - Na + H_2O$$

that is the changing of the mercaptans, R-S-H, into sodium mercaptide, RS—Na, and water.

For the elimination of the heavier mercaptans, R-S-H, the gasoline will be treated with a strong solution of—

Cupric Chloride, $CuCl_2$

The composition of this solution is:

$CuSO_4 + 5\ H_2O$ = Copper sulphate.
$NaCl$ = Sodium chloride.
H_2O = Water.

The reaction with the mercaptans takes place in two stages:

1. $4\ (R\text{-}S\text{-}H) + 2\ CuCl_2 = (R\text{-}S\text{-}S\text{-}R + 2\ RSCu + 4HCl$
2. $2\ RSCu + 2\ CuCl_2 = (R\text{-}S\text{-}S\text{-}R) + 4\ CuCl$

As in the doctor treatment, the mercaptans R-S-H are changed into alkyl disulphides, R-S-S-R, which are soluble in gasoline and do not react with the sodium plumbite in the doctor test.

For further reduction of the sulphur content, the gasoline will be given an acid treatment.

The cupric chloride, after having been in contact with the oil, is reclaimed and regenerated by blowing with air for the oxidation of cuprous chloride, Cu_2Cl_2 (4 CuCl), formed during the reaction of the mercaptans with the cupric chloride, $CuCl_2$. The regenerating process is:

$$4\ CuCl + 4\ HCl + O_2 = 2\ H_2O + 4\ CuCl_2$$

This formula shows that there is no loss of cupric chloride due to the chemical reaction during the treating and regenerating process.

The cupric chloride treatment seems to be better than the doctor treatment, probably for the reason that the cupric chloride attacks more the heavy mercaptans, which are not affected in the treatment with doctor solution. No free sulphur is needed for precipitation, which is a great advantage.

Results

The cupric chloride does not remove any sulphur from the oil, but merely changes the mercaptans, R-S-H, into alkyl disulphides, R-S-S-R, which are again soluble in the oil, but which do not affect the doctor test—the oil being considered then as sweet.

Cupric chloride solution is very corrosive and will attack nearly all metals and concrete. The necessary containers and pipe lines must be made of special material such as glass, wood, bakelite, hard rubber.

For further reduction of the sulphur contents of the oil, it must be subjected, after the cupric chloride reaction, to an *acid treatment.*

Preliminary experiments have shown that the 66-degree Beaume sulphuric acid should be mixed with the oil in two stages, which should require not more than about 4 pounds acid.

By this method, the sulphur content is reduced in the finished gasoline.

Major Sanguinet Passes On

EUGENE OBERLY SANGUINET, vice-president and sales manager of William S. Barnickel & Co., and member of a pioneer St. Louis family, died November 4th at St. Anthony's Hospital, St. Louis, after he failed to rally from an operation. Although in ill health for nearly two years, he had attended to his business affairs until a few weeks before his death.

During the World War he organized the 131st Field Artillery at Houston, Texas, and served overseas with the rank of Major in the Thirty-sixth Division. He was a member of Battery A, Missouri National Guard, for 24 years and a veteran of the Spanish-American war. His service record in the U. S. Army is quite long, and includes many important battles.

During his service in Battery "A" he met and became fast friends with the late William S. Barnickel, and in 1919 became Texas and Louisiana representative for W. S. Barnickel & Company, with headquarters in Houston. In 1921 he was transferred to St. Louis and assumed the duties of sales manager and in 1923 was appointed vice-president.

"Major" as he was known by many oil men, was born in St. Louis on November 2, 1872. In addition to his widow he is survived by seven brothers.

Same Device Caps Three Famous Wild Wells

THE American Iron and Machine Works Co., Oklahoma City, Okla., enjoys a unique distinction in connection with the handling of unruly high pressure wells which are not uncommon in that area. It was with their special die nipple and hook-up that the three most spectacular and world renowned wild wells were shut in—"Wild Mary" Sudik No. 1 of the Indian Territory Illuminating Oil Co.; Prairie-Slick's Signon No. 1, and Stout No. 1, Morgan. The hazardous location of these wells and the tremendous loss of oil necessitated the quickest action possible. American Iron and Machine Works Co. engineers concentrated every effort on the job and succeeded in working out a device which accomplished what had begun to appear an impossible task.

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Grooves in the "greater production" *Layne Milled Groove Screen* are so spaced that the drainage distance between the Keystone Wires is very short, eliminating the possibility of openings becoming clogged with mud or sand.

The *Layne Milled Groove Screen* has the remarkable ability to safely stand 8,000 feet of drill pipe, it prevents sand cutting, is a tonic to low pressure wells, and increases production from 33 1-3% to 100%.

Large and important companies abroad and in this country will testify to *Layne Milled Groove Screen's* sensational, remarkable, outstanding superiority.

Install the "greater production" *Layne Milled Groove Screen* instead of wishing you had.

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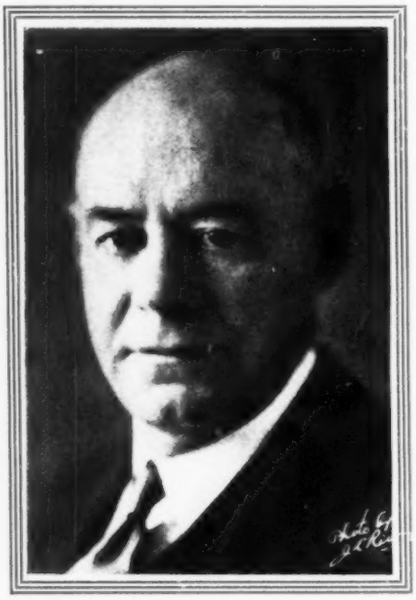
Exposition Sponsoring

Home *for* "Old-Timers" *of* Oil Industry

A HOME for the "old-timers" of the petroleum industry! After being talked about in certain circles of oil men for a number of years this may become a reality if plans launched in Tulsa are carried out. The first definite step toward the realization of this program was the authorization of William B. Way, manager of the International Petroleum Exposition, by the directors of the latter organization, to proceed immediately with a study of plans necessary for such a home.

The Exposition has for several years had an "old-timers" association in connection with its activities and it now proposes to go even further. Barney Horrigan, Tulsa oil producer and member of the board of directors of the Exposition, is head of this association and is generally given credit for its founding. The membership of the association has increased rapidly during the past few years; all of the members have served in the industry from 35 to 70 years.



Barney Horrigan,
Chairman, Old-Timers' Association

Considerable interest has been displayed in the plan for an old-timers' home by a number of prominent oil men since the matter was first discussed and with the news that at last some definite step had been taken, this interest has increased to a surprising degree. Several oil men have stated that they would be willing to donate funds toward the setting up of such a plan. However, Mr. Way has let it be known that no public drive for funds would be made. Exactly how it would be financed, just who would care for it, and how it would be supported and operated, must be worked out. There are several plans under consideration but it is the wish of the officials in charge to first hear from the oil industry.

Many leading oil men are of the opinion that this would be a worthy tribute to the oil pioneers who served in the infancy of the industry. If this should be accomplished, it will be the first time the oil industry, as a whole, has undertaken such a great philanthropic step for the relief of its aged members. Plans are for the home to be international in scope.

This has been, perhaps, the most interesting announcement to come from Exposition headquarters since the close of the show in October. The 18-month period between now and the next Exposition offers the men working on the proposed home plan, plenty of time to work out the details before the next big gathering of oil men on the Exposition grounds.

At the last Exposition there were about one hundred of the old-timers entertained at lunch, although the membership is six times that many. Badges were given to each of them, as has been the custom, indicating long service in the industry, and gold badges were given to those chosen Grand Old Man of the Industry and Grand Old Man of Tulsa. The next Exposition is expected to see an even greater number of old timers and plans are being laid for the entertaining of these pioneers.

Another very interesting announcement that has been made by Mr. Way is the proposed offering of a suitable award for an outstanding accomplishment in the petroleum industry. This award was proposed by Henry L. Doherty and is to be donated by him at the next Exposition and probably at each succeeding one. Mr. Doherty has asked that a committee be named to draw up plans for this award and that the plans be submitted to him for approval. In this connection the A. S. M. E. has already been asked to appoint a committee to make suggestions to the Exposition Committee, and similar organizations are to be asked to appoint committees for this work.

An effort is to be made to secure more association meetings during the Exposition in the future. The past Exposition witnessed the holding of a three-day meeting of the American Society of Mechanical Engineers at the Exposition auditorium.

The seventh annual International Petroleum Exposition at Tulsa, last October, was by far the most successful that has been held, from every standpoint.

Perhaps the most outstanding indication of the growth of the Exposition was the space sale and the number of exhibitors' contracts, which indicated that the show was about 30 per cent larger this year than last year and that the percentage of 1929 exhibitors who exhibited in 1930 was 76 per cent as compared with 58 per cent of the 1928 exhibitors who showed in 1929.

Another very pleasing success was that of the refining and marketing equipment exhibits, which was a new development this year. Undoubtedly this new phase of the Exposition will be greatly increased at the next show, which will be held in May, 1932.

Attendance records for any Exposition were also broken, when 122,671 persons passed through the gates. The highest single day attendance record was also surpassed several times, with Friday, October 10th, finally taking the lead with 20,994.

The show is rapidly gaining prominence as an international project. This was shown by the fact that there were about eight delegates from 20 foreign countries in attendance. This year Venezuela and Poland had exhibits and already requests have been received for space for exhibits from Mexico and Venezuela for the 1932 Exposition.

This year an attempt was made to secure the registration of the guests. There were about 35 persons employed during the week for this work, and they were stationed in various parts of the grounds. That the method used is entirely feasible is shown by the fact that some 18,000 names of people in the industry were obtained. This list of names is a valuable service rendered to the exhibitors.

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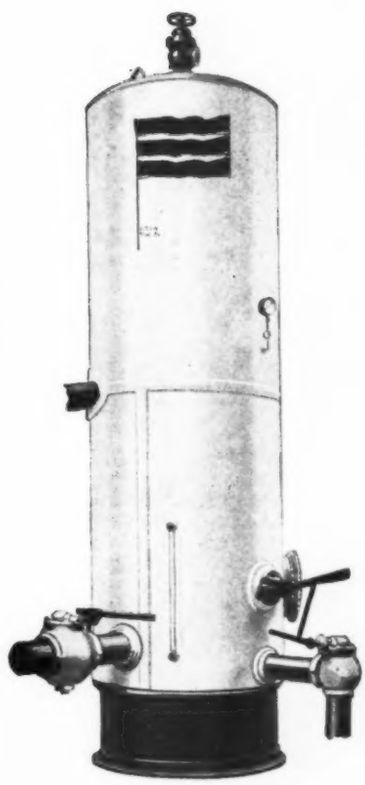

This Separator is always ready to function, without elaborate preparation. It is "raring" for action, and when in action, performs like a real soldier.

There is greater capacity due to the inside man-sized float—ten times the ordinary capacity, and there is no waste of the oil, as the B S & B Spray Condenser completely strips the gas dry, assuring the user 100% of the crude.

"On with the battle" was a term used by the American Engineers until they completed this Improved American Oil and Gas Separator, after two years of designing, building and testing. This Separator is built as strong and sturdy as an army tank—of extra thick flange steel. It has every feature of strength, and numerous features for convenience.

Put an AMERICAN on that well, and let it go into action for you!

For Cold Weather

A separate steam jacketed float chamber is not required on the Improved AMERICAN, because it is equipped with the inside float. All Separators are equipped with steam coil connections for inside steam coils.

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American Tank & Equipment Corp.

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Gaso Pump and Burner Gets New Foreign Order

THE Gaso Pump and Burner Mfg. Co., of Tulsa, Oklahoma, reports good business, which is keeping their regular force steadily employed and the plant running on the usual production scale.

This company recently made a shipment to the Standard Oil Company of New Jersey. It consisted of six large pumping units for its Venezuelan operations, a shipment of 32 pumps to the Baku field in Russia, as well as to Trinidad, Egypt and many other foreign ports.

The Gaso people are always endeavoring to keep abreast of the engineering field in pumping equipment, and have brought out many new models and types to meet the changing conditions in the industry. They only recently have announced a completely enclosed, Timken-bearing equipped pump, also a worm-drive application to a pump for the use of high speed driver with only one internal reduction, this also being fully Timken equipped.

This company has in process at this time a newer unit that, they say, will be a revelation in the pipe line pumping field. This pump will be announced in the near future, as it has been fully checked and tested for service for which it is designed to perform.

Convention of Rocky Mountain Association

THE sixth annual convention of the Rocky Mountain Oil and Gas Association was held on December 12 and 13 at the Rainbow Hotel, Great Falls, Mont. The meeting was a joint one with the Oil and Gas Association of Alberta, a custom that was instituted last year by a joint convention at Calgary.

Business sessions were held in the morning and afternoon of both days and included a meeting of the state committees of Wyoming and Montana of the National Code of Marketing Practices.

Novel Card Model of Inductance Bridge Principle

THE Brown Instrument Company, Philadelphia, Pa., are sending out to power plant and industrial plant officials throughout the country a novel illustration of the inductance bridge principle as applied to flow meter design. They have received many letters expressing the great interest the recipients feel with respect to this unusual card model, which demonstrates fully the operation of the Brown Electric Flow Meter, which operates on the inductance bridge principle.

Its automatic planimeter records volume units of flow on chart rim; it has six ranges with one manometer; it is equipped with a forged steel manometer; tested to 1,500 pounds; with special models tested to 2,500 pounds pressure, with other models from 5,000 to 10,000 pounds.

These may be secured by merely writing the Brown Instrument Company at Philadelphia, Pa.

Another Democrat

AUDREY CAROLINE, infant daughter of Mr. and Mrs. J. H. Hatch, was baptized at Trinity Episcopal Church, Tulsa, Okla., December 14. The godfathers were Phil D. Morelock of Kansas City, Mo., and C. G. Williams of Tulsa, Okla. Mrs. Morelock and Mrs. Williams served as godmothers. Mr. Hatch is secretary-treasurer of the Union Wire Rope Co., Tulsa, Okla.

E. E. Greve Again Heads Committee

E. E. GREVE, who has been chairman of the Manufacturers' and Engineers' Sub-committee of the A. P. I. since its organization, and who serves on a number of other important committees, is chief engineer of the Oil Well Supply Company. He has held the latter position since the spring of 1912.

Mr. Greve has been an untiring worker, and was among the first to work on standardization of oil field equipment. He was a member of the Rig Iron Committee when the Tulsa Purchasing Agents' Association first started standardization work. In addition to being a member of the A. P. I., he also belongs to the A. S. M. E., American Society Testing Materials and Engineering Society of Western Pennsylvania.

Mr. Greve was graduated from the Stevens Institute of Technology, also from the Colorado School of Mines. He spent some time in mining and civil engineering work, after which approximately three years were spent in the oil fields of California before joining the Oil Well Supply Company.

Ampco Metals Opens Tulsa Office

OPENING of a Mid-Continent sales and engineering office at 327 Exchange Bank Building, Tulsa, is announced by Ampco Metals, Inc., manufacturers of Ampco metal.

Ampco metal has been produced during the past fifteen years, primarily for operating conditions of unusual service, but is now being offered to the oil industry for the first time.

Ampco metal may be had in several grades. According to the manufacturers, it is immune to the corrosive action of hydrogen sulphide, sulphuric or sulphurous acids, as well as many other commercial acids widely used in the oil industry, is highly resistant to a wide range of active acids and alkalies in their concentrated form and has a very high tensile strength.

Ampco may be used for pump liners, plungers, piston rods, gate valves, valve seats, flow valves, chokes, non-sparking tools and many other products, such as bearings, gear blanks, forming dies, wire drawing dies and acid pump parts, state the manufacturers.

This company recently changed its name from the American Metal Products Company to Ampco to tie up with the trade name.

C. Allen Fulmer is in charge of the Tulsa office and additional information on this metal may be secured from him

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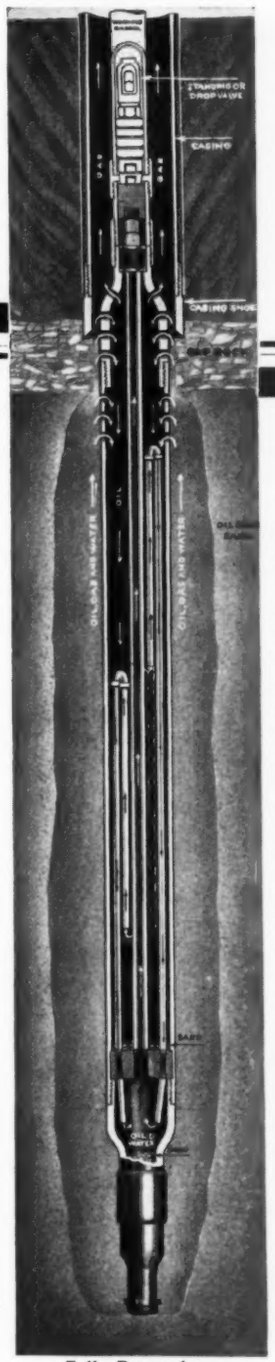

The Chancellor Separator is manufactured in lengths of 8, 10 and 12 feet, with an outside diameter of 4¼". Special sizes are made to order. We welcome your inquiries. If you are treating your oil or have a bad well that you cannot pump, advise us. Write for our descriptive pamphlet.

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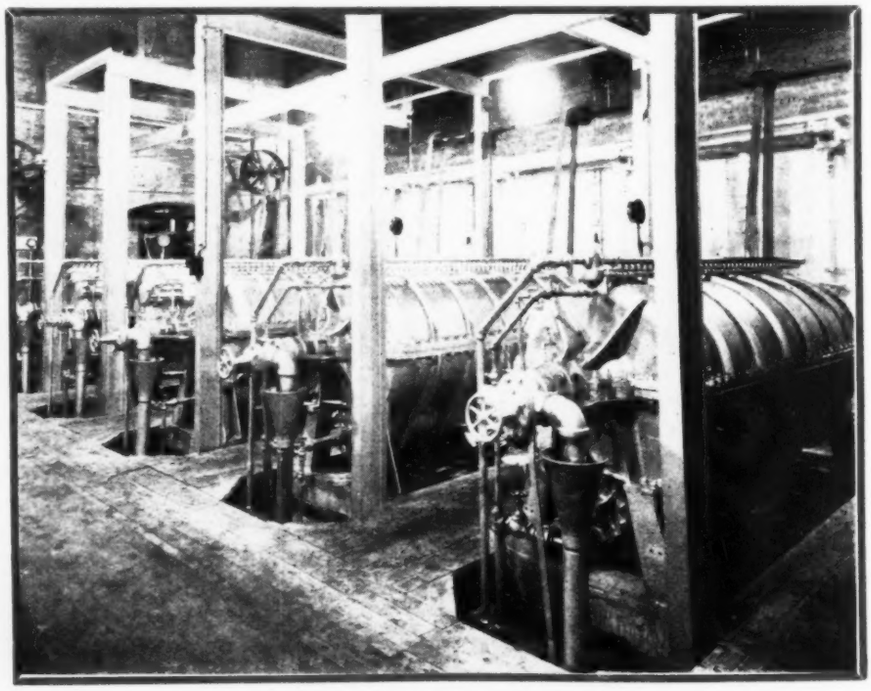
Contact Filtration *in* Petroleum Refining

By L. P. WHITE *

TRYING to give a complete survey of contact filtration, even in one section of the country, is like attempting to count the spots on a restless leopard. It can hardly be said that there are unlimited variations, although they are numerous. A few of the various methods will be mentioned briefly and the accompanying flow sheet will be briefly discussed. There may be some who will disagree with the remarks in the following paragraphs. To these we say that the material set forth here is the result of considerable work on contact, plus information received from various sources during that time.



Filter press installation for contact filtration.

Before getting too deeply into the operation itself, let us consider the elements that enter into the work. Aside from the nature of the stock and its treatment before contacting, the clay, the temperature and time of contact must be given careful consideration. There are one or two other factors concerned which will be considered jointly with the clay.

There are two general types of clay on the market, natural clay and clay that is chemically treated before selling, "acid-treated clay". There has been considerable discussion from time to time regarding the respective contact value of each type of clay.

It has been the writer's experience that the acid-treated clay has two, and sometimes two and one-half times the contact value of natural clay. This is completely in accord with outside information from users. In other words, one-half pound of acid-treated clay will do the same amount of work as will one pound of natural clay. Offhand one would think that this is a decided advantage for acid-treated clays. This is not necessarily so, as the cost is almost four times that of natural clay and the reactivation cost is also higher. This will be discussed at greater length later.

Natural clay, whether one hundred mesh or two hundred mesh, has the same general characteristics. Naturally these vary with the locality from which the clay comes. Let us consider one particular clay. As received at the refinery, we find it contains about 10 per cent moisture. Of course, this may vary from exposure, leaky roofs or storage in a damp place. At the refinery this is not likely to take place, but much can happen before it gets to its destination. As it arrives, the clay cannot be readily used in hot oil due to foaming. It is, therefore, dried before using. It is also found that completely dried clay is not as efficient as clay containing some moisture. There is no gainsaying the fact that a certain amount of moisture, causing a slight blanket of steam over the surface layer of oil, does help to prevent oxidation. So, in using the clay either drying is not carried to completion or a proportion of the total amount of clay is used undried. Highest efficiencies on this particular natural clay were obtained when the clay contained around two per cent moisture.

The moisture content of acid-treated clays usually runs around 15 per cent. This type of clay loses some of its value upon drying, and therefore, in general, should not be dried. It should be added to the oil at such temperatures or in such a manner that foaming will be avoided. Some of these clays, one in particular, show a decided variation in quality from time to time. Each shipment has to be checked to insure proper application.

Another of the acid-treated clays has a remarkable property in that it can be pulped with water, and added to the oil as a slurry. In this case the clay is added before the oil is up to contact temperature, thus avoiding foaming. So far as the writer has been able to find out, there are very few clays which may be used in this manner. Apparently, high alumina content is the determining factor in this type of clay.

Among the most notable variations between treated clays and natural clays, is the type of filter cake built. Natural clays form a more porous cake resulting in higher rates of flow, easier washing and freer discharge. On the other hand, treated clays form denser cakes, the pressure rising due to packing, something it does not generally do on natural clays. It does not require more wash than a natural clay cake, but it does require a little more time. One important item is that a longer filtering cycle may be used with

* Chemical Engineer, Goslin-Birmingham Mfg. Co.

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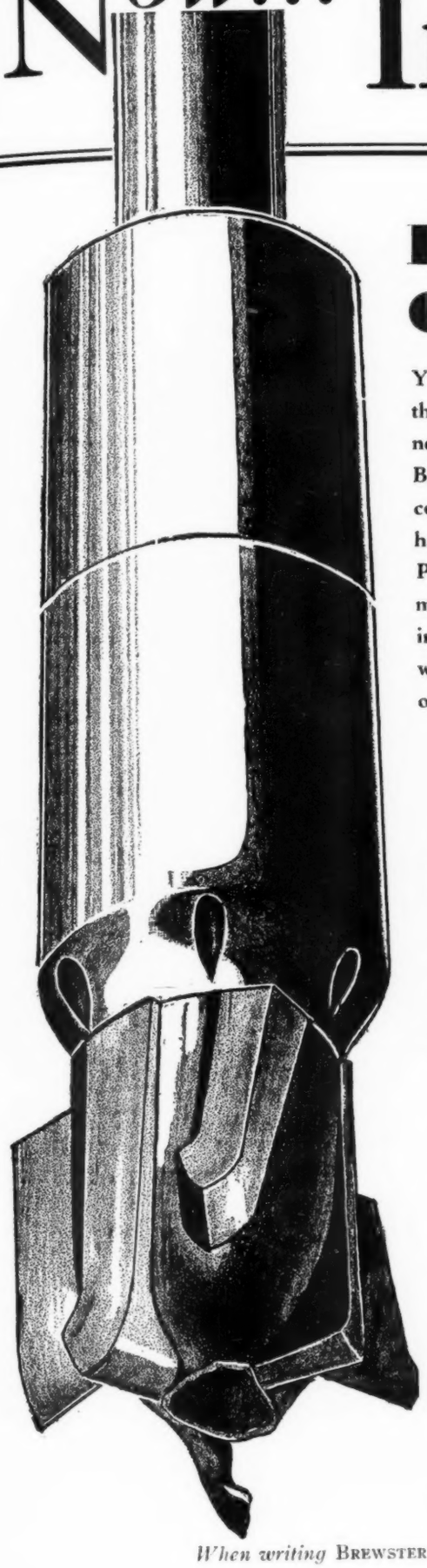

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treated clays due to the smaller amount of clay necessary to effect the same amount of decolorization. This last tends to increase overall filtration rates, and generally overcomes the lower rates of actual flow while filtering.

Filter capacity is principally based on the total thruput per square foot of filtering surface. Total thruput depends not only on actual rate of flow while filtering, but also on the quantity of clay per gallon of oil, thickness of cake formed, and the amount of non-productive or "down" time per cycle. It may be expressed as follows:

$$R = \frac{Wr}{W + PrD}$$

where: R = Total thruput in gallons per square foot per hour.

r = Actual rate while filtering in gallons per square foot per hour.

P = Proportion of clay—pounds per gallon.

W = Weight of clay formed per square foot filtering area per cycle (this is based on thickness and specific gravity of cake).

D = Down time per cycle—fraction of hour.

Two of the above factors—r and w—(rate of flow and the cake thickness factor) are directly inter-related, and should be considered jointly. However, if we overlook this fact for the moment we can readily see that, other factors remaining constant, thicker cakes and higher rates of flow increase the total thruput, while higher proportions of clay on oil and longer down periods decrease thruput. Natural clays, as compared with acid-treated clays, form as thick or thicker cakes with higher rates of flow, and require shorter "down" periods due to faster washing and discharging. Less proportion of treated clay is needed, however, and this generally offsets the other factors.

To consider an actual case, assume stock requiring 1 pound per gallon (dilute) of natural clay or .5 pounds of treated clay. Rates of flow will be about 60 gallons (dilute) per square foot per hour on natural clay or 30 gallons on treated clay. Down time on natural clay will run about 35 minutes or 45 minutes on treated clay; cake thickness on natural clay 2 inches or 6 pounds per square foot, or 5 pounds per square foot on treated clay.

Substituting these values in the above equation:

$$R \text{ (for natural clay)} = \frac{6 \times 60}{6 + 1 \times 60 \times .582} = 8.8 \text{ g/sq. ft./hr.}$$

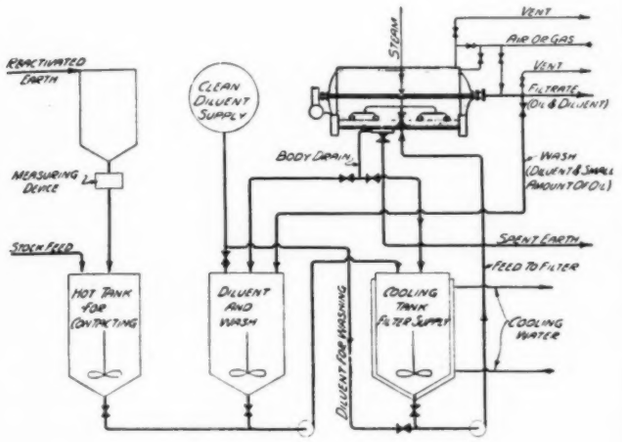
$$R \text{ (for treated clay)} = \frac{5 \times 30}{5 + .5 \times 30 \times .75} = 9.2 \text{ g/sq. ft./hr.}$$

In this case we see that there is very little difference in thruput. However, in general, it may be said that treated clays require less filter capacity. This is more pronounced when thinner cakes are formed, as a closer leaf spacing within each filter unit may be used, thus increasing the net thruput per filter, especially on certain acid-treated, where actual rates of flow decrease materially as thicker cakes are formed.

Ultimately the question of which kind of clay to be used must of course be boiled down to a cost basis. In Pennsylvania, natural clays vary in price (delivered) from sixteen dollars ($16.00) a ton to twenty-six dollars ($26.00) a ton. Treated clays cost from forty dollars ($40.00) a ton to seventy dollars ($70.00) a ton. Two to two and a half times as much natural clay is required as treated. Assume we are going to contact one hundred barrels of stock per day, making bright stock, and it requires three pounds per gallon of natural clay to accomplish this work. On this basis 6.3 tons of natural clay will be required to do as much work as two and a half to three and a quarter tons of treated clay.

Thus, considering clay cost only, natural clay (at an average price of $22.00 per ton) would cost $140.00 per day as against roughly $145.00 to $170.00 per day on treated clay. Based on these figures only, it would seem that natural clays are cheapest.

However, as we have already seen, somewhat less filter capacity is required with treated clays. Also it must be remembered that the more clay used, the more oil lost in discharged cake. On some filters, however, where the cake may be washed very thoroughly, actual losses will run less than 0.15 per cent of the total thruput even where low efficiency natural clays are used. More filtering cycles will, of course, be made with greater quantities of clay, and naphtha losses be proportionately increased. Again, on closed filters, this is not an appreciable item of cost as naphtha losses are proportionately very low, due to all closed operation.



To the Mid-Continent refiners, the proportion of clay necessary to decolorize Pennsylvania stock will probably seem high. On experimental work, as high as four pounds of natural clay per gallon of stock has been used. It should be borne in mind, however, that all the decolorization is done by the clay proper in general Pennsylvania refining practice.

This brings us to one of the most important phases of contact filtration, especially as concerns the Pennsylvania refiner; namely, reactivation of spent clay. In some fields discarding is possible, but where clay costs are prohibitive some method of reusing the clay must be had. Burning is in general use at present. It cannot be truthfully said that this method is entirely successful. Losses through clay being dissipated as dust, commonly run as high as 13 per cent of the total charge to the burner. Unless careful temperature control be exercised, reactivation by burning, especially on treated clays, will run as low as 75 per cent. Natural clays do not require quite as careful handling as the treated clays (another feature to be considered in choosing the proper clay). Makeup will vary with the efficiency of reactivation, from 10 per cent to 20 per cent of the total clay used. When burning, it is figured never to throw the clay away, enough is lost each burning to keep a balance all the time.

Before going further, the writer would like to comment generally on reactivation. It has been the nightmare of the experimental work conducted. Tests have proven burning rather costly in more ways than one. With the assistance of one of the large solvent manufacturers, who have devoted considerable time and money to the development of a solvent, a new process for reactivating clay by means of solvent extraction is being developed. Until data is com-

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. . . For use in the Pictorial Petroleum Section, The Petroleum Engineer desires unusual and interesting photographs. These may be of field scenes, new installations, new hook-ups, individuals, or any subjects likely to appeal to men in the petroleum industry. Especially do we want pictures of "old-timers" who are still active in the business and views with a foreign setting.

If you have such photographs, we shall appreciate your permitting us to reproduce them in our pictorial section. Extreme care will be exercised in handling them and they will be returned in the same condition as received. Kindly address photographs to

THE PETROLEUM ENGINEER
Exchange Bank Bldg. Tulsa, Okla.

plete, it is impossible to go into this work more fully. We may state, however, that glazing through burning is eliminated and that the clay is not dried to a dust until just before re-use, so dust losses are negligible. Also all work to date points to the losses of solvent being exceedingly low. The writer will write up the process in The Petroleum Engineer as soon as sufficient development work has been carried out.

In the typical plant here described, all extra tankage, etc., has been eliminated, and the flow sheets made as straight line as possible. There are countless possible variations in such layouts—this one has been made as simple as possible in accord with the most common practice of making dark bright stocks.

Stock is fed into a contacting kettle either directly from the still or from a preheating unit. A mechanical measuring devise adds the proper amount of clay. The mixture is constantly agitated and kept at the contacting temperature throughout the contact period which will be from one to two hours. The mixture is then pumped to a cooling tank where the diluent is added. This tank serves as the press feed tank. The clear filtrate is carried to the dewaxing plant. The cake is washed and the wash naphtha used for diluting the next batch of oil. In this way the total amount of naphtha handled is materially decreased. The cake is partially dried by air or an inert gas and completely dried by steaming. A condenser is used in the circuit for recovery of volatilized naphtha from the steaming. The vent lines are all carried to a central vent tank where any naphtha vaporized is recovered and returned to the system. This does not mean that there is no loss of naphtha, yet in conjunction with the Vallez Filter closed operation it does keep the loss exceedingly low.

Before concluding this article, it might be well to run over the advantages of contact filtration in general. The greatest single advantage is in the oil being to the proper color from the time the filter goes on stream until it comes off, eliminating the necessity of readding some of the tarry materials being removed, to bring the tank up to color. This, of course, gives a more uniform quality of stock, which notably improves the lubricating oil produced. Simplicity of operation, more accurate control and quicker turnover also have their place in this list.

In conclusion the writer would state that, as has already been indicated, the bulk of the data and information herein contained is the result of work done principally in the Pennsylvania field. The wide variation in practice in other fields is fully realized, and for that reason, no definite conclusions are stated. The field is too broad and there are too many variations for anyone to lay down definite and concise limitations to the work.

New Lufkin Catalog

PRODUCTION men will be interested in the new 120-page catalog No. 31 now available from The Lufkin Foundry & Machine Co., Lufkin, Texas. This catalog is a complete handbook relating to the application of the reduction gear (both worm and herringbone) for pumping and drilling.

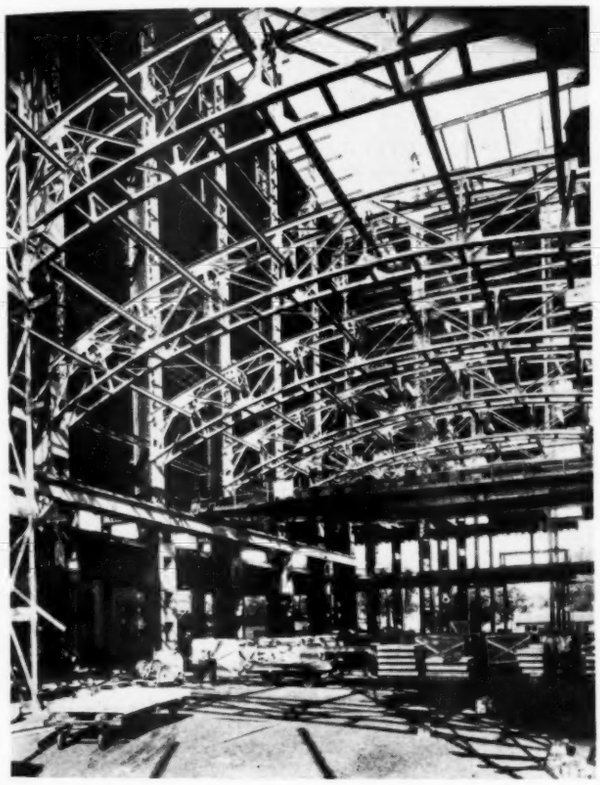
Illustrated with blue prints of setting plans, hook-ups of all types of unit applications and supplemented with charts and diagrams, the catalog is especially valuable to oil company engineers. Historical data on the development of the Lufkin unit are included in a special sepia section in pictorial form. The catalog, attractively bound, will be mailed without cost to interested oil men anywhere upon request directed to the Lufkin office.

A. O. Smith's Research Building

IT is rather strange to find, in the heart of a building noted for its architectural beauty, so utilitarian a piece of machinery as a crane; and even stranger, perhaps to find the craneway in keeping with the beauty of the structure. But that is what has been achieved in the new Research and Engineering Building now being erected by the A. O. Smith Corporation in Milwaukee.

The building was planned as a laboratory in which the A. O. Smith Corporation's engineering force is to carry on its industrial development work. Much of the company's work is done with steel in large masses, so a crane had to be provided in connection with the laboratory to lift these heavy weights.

The building itself is of strikingly "moderne" architecture and most unusual in treatment. Its impressive facade, built almost entirely of glass and aluminum, its new hollow column construction, its battle deck floors and many other newly developed features have attracted the attention of architects and engineers all over the country.



For instance, the battle deck floors, developed by the A. O. Smith Corporation, are unique insofar that they consist of plates slotted for spot welding onto the floor beams and girders. Another new feature is the steel grid recently developed and now produced by the A. O. Smith Corporation. The grid is tack-welded to the battle deck for reinforcement of the concrete floors.

The huge craneway occupies the court of the structure, which is U-shaped in plan. In keeping with the "moderne" architecture and construction of the building, it is spectacular in effect. Eight consecutive eighty-foot arched spans, each three feet square and with a ten-foot rise, support a vaulted glass and concrete skylight one hundred and sixty feet long.

The skylight is erected over the court at the third floor level, and the craneway at the second floor. This allows for a twenty-four foot lift which is adequate for the needs of the research laboratories. The crane itself has a capacity of twenty tons.

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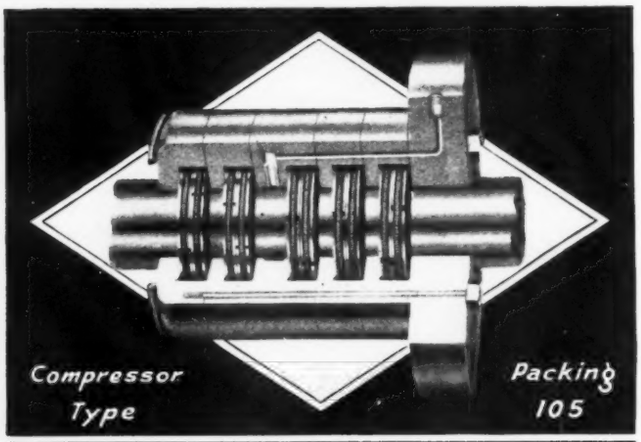
Plant and Office: Fort Worth, Texas

COOK'S GRAPHITIC IRON ROD PACKING

Are You Paying For Cook's Packings Without Getting Them?



THE basic requirements of an efficient packing are: (1) long life (2) absence of rod wear, (3) positive seal, (4) floating so it does not act as a bearing, (5) self-adjusting, (6) minimum friction.

In buying packing you pay for these qualities, and you have a right to expect them. Anything short of that does not give you the packing efficiency you have a right to demand.

COOK'S Metallic Packings are exclusive in design and materials. They are the only floating packings using Graphitic Iron wearing rings so as to meet all these requirements.

Are you paying for COOK'S Packings without getting them? Ask for Bulletin 129.

C. Lee Cook Manufacturing Co., Inc.
LOUISVILLE, KY.
Tulsa New York Agents in Principal Cities Los Angeles

"Sealing Pressures Since 1888"

The girders, which form the supports for the skylight, are of hollow construction, as are all the columns and girders in the entire building. The glass and concrete skylight is supported on shelf angles attached along the axis of the girder. This, of course, permits part of the girder to extend above the skylight. The extending portion is encased with insulation and aluminum flashing. Below the roof, the girders are plaster encased.

As a precaution against condensation on the under side of the skylight, warm dry air will be blown through ports placed at intervals along the sides of the girders. The air is warmed by a mechanical ventilation system which conditions the air for the entire building.

On the second floor of the building, glazed partitions separate the wings of the U from the craneway, and an observation platform with an ornamental aluminum railing extends the full width of the interior end of the craneway. The exterior end of the craneway is glazed with five expansive windows extending from the sill line to the springline of the arched trusses above. At the first floor, the partitions between the wings and the craneway are omitted, making the entire first floor of the building one large room.

Throughout the building, every facility has been placed almost literally at the very elbows of the engineers and scientists who will use the structure as a workroom for their industrial development and research experiments. Steam power lines, high tension electric lines for welding, gas lines, compressed air lines, fuel oil lines and even oxygen lines are carried to all parts of the building through the hollow columns and girders—a unique feature that has attracted wide attention. The finest and most up-to-date equipment for every type of laboratory work has been provided. Nothing has been omitted that would in any way tend to advance the cause of science and research.

The A. O. Smith engineering force, which will carry on its work in the new Research and Engineering Building, now consists of 500 men, but is soon to be increased to a round thousand.

Blackor Company Mid-Continent Headquarters

THE Blackor Company, Los Angeles, has announced that effective on November 1 headquarters will be maintained at both Tulsa, Oklahoma, and Houston, Texas. A. N. Muhr will be in charge of the office at Tulsa as representative for Oklahoma and North Texas, and Ross Ledford will be located at Houston as representative for South Texas.

Both men are well known in the oil industry, having had many years of field experience. This arrangement is expected to prove of assistance in enlarging the service of the Blackor company in the Mid-Continent and Gulf Coast areas.

Alloy Welding and Manufacturing Company Announcement

AN announcement has been made to the effect that the welding and manufacturing business formerly conducted by the Pittsburgh Producers Supply Company is now conducted by the Alloy Welding and Manufacturing Company. This company is manufacturers and welding engineers in steel and alloy metals. The personnel and policies of the company will remain unchanged.

General offices and plant are at Pittsburgh, Pa., while J. P. Dobbins is the company representative at Tulsa, where offices are maintained at 733 Mayo Building.

Announce New Foamite Device

A NEW foam-producing device, known as the Foamite Duomixer, has just been announced by the American LaFrance and Foamite Corporation of Elmira, N. Y.

The new device is used in a system known as the Foamite Dual Powder System. Designed primarily for stationary use, the Duomixer is a two-hopper device, one hopper being used for the "A" part of the Foamite Dual Powder and the other for the "B" part.

Because of the fact that the "A" and "B" parts of the powder are poured into separate hoppers, foam is not produced at the Duomixer as is the case with single powder Foamite generators manufactured by the company. Instead, the resulting solutions flow through twin pipe lines, terminating in mixing chambers or nozzle sets. With this set-up, the Duomixer may be located as far as 1,500 feet from the risk to be protected.

Campbell Equipment for Sugar Creek Plant

THE Louisiana Gas and Fuel Company select Campbell equipment for their Sugar Creek high-pressure (500 pounds) gasoline plant, to be erected near Arcadia, Louisiana. The contract, awarded to Stearns-Roger Manufacturing Company of Denver, Mid-Continent representative of the J. A. Campbell Company, calls for Campbell equipment throughout. The plant will handle 30 million cu. ft. of gas and is designed to produce 30,000 gallons of gasoline daily. It is scheduled to be put in operation within 90 days. This will make the third plant built for the Louisiana Gas and Fuel Company within the past two years in which Campbell equipment was specified throughout.

Dravo-Doyle Opens Chicago Office

DRAVO-DOYLE COMPANY announces the opening of an office in the Marquette Building, Chicago, Ill. This office is for the exclusive representation of the following manufacturers: C. H. Wheeler Manufacturing Company of Philadelphia, Pa.; The Tri-Lok Company of Pittsburgh, Pa.; Fuller Company, Catasauqua, Pa., and the James M. Seymour, Inc., East Orange, N. Y.

F. A. Faville is district manager in the Chicago office for the Dravo-Doyle company.

Harrisburg Pipe Control Sold to Corbett Corporation

E. B. CORBETT, president, The Corbett Corporation, Houston, Texas, has announced the purchase by his company of the control of the company formerly known as the Harrisburg Pipe & Pipe Bending Company of Texas from the Harrisburg Pipe & Pipe Bending Company of Harrisburg, Pa. The company will henceforth be known as The Corbett Corporation.

Victor Manufacturing Places Big Order

AN order for 7½ million pounds of rolled sheet copper for current and immediate future needs has been placed with regular suppliers by Victor Manufacturing & Gasket Co., Chicago. This company's principal product, copper-asbestos gaskets, is widely used in the automotive field. John H. Victor, president, says: "Our feeling that there will be better prospects and an improvement in our business is such that we have felt warranted in making the purchase at this time to cover our needs for the next few months.

B-M-W PRODUCTS for pumping wells
The KEY to LOWER LIFTING COSTS
CORRECTLY DESIGNED · · ECONOMICALLY PRODUCED
REASONABLY PRICED

Name your pumping problem—
there is a B. M. W. ball and seat to meet it!

B-M-W CHROMARD
Stainless Steel—non-corrosive—stands up under cutting action of floating sand.

B-M-W BRAMO
General purpose ball and seat—high grade tool steel—moderate in price.

B-M-W BI-METAL
Chromard Seat and Extrard Bronze Ball—for use where loadstone and floating sand are present.

B-M-W EXTRARD BRONZE
Extremely hard bronze alloy—will perform where loadstone and corrosive elements are present.

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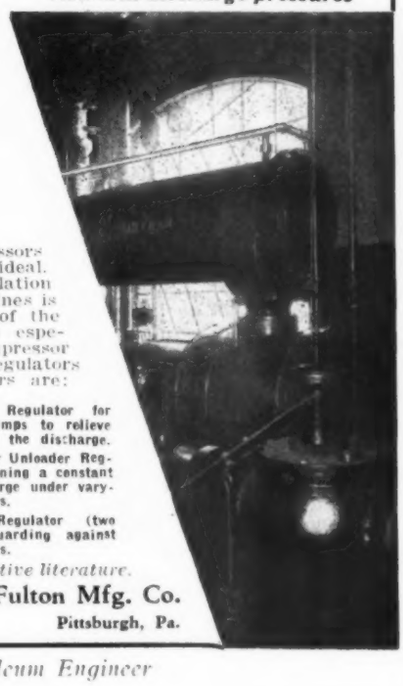
C-F Regulators for Compressors
give dependable regulation of suction and discharge pressures



For gas or air compressors C-F Regulators are ideal. Every need for regulation on intake and outlet lines is provided for by one of the three C-F regulators especially adapted to compressor service. The C-F regulators used with compressors are:

(1) C-F Compressor Regulator for constant speed pumps to relieve excess pressure at the discharge.
(2) C-F Throttling, or Unloader Regulator for maintaining a constant pressure at discharge under varying load conditions.
(3) C-F Vacuum Regulator (two types) for safeguarding against dangerous vacuums.

Write for descriptive literature.

The Chaplin-Fulton Mfg. Co.
28-40 Penn Ave. Pittsburgh, Pa.

Methods Used in

Cleaning Rotary Mud

By
GEO. L. MOREHEAD*

A Link-Belt vibrating screen used by the Humble Oil & Refining Company in the Hobbs (New Mexico) field for salvaging mud from old pits. At the time this photograph was taken, between $10,000 and $15,000 worth of mud had been salvaged through the screen. Notice the cuttings in the foreground, and how effectively the screen rids the old mud of foreign materials, thereby fitting it for economical re-use.

CLEAN mud — the expression in itself is contradictory. The layman can hardly associate mud as mud, with cleanliness, nor can he associate cleanliness with mud. However, to the man who operates rotary drilling equipment in the oil field, the expression "clean mud" has a very definite meaning. In fact, to him it stands for that alluring thing that he has always wanted but seldom had on a drilling operation. Clean mud or cleaning mud is not synonymous with the painstaking operation that mother performed on Johnny's ears just before he started to school. What his kind mother peeled off and threw away is just the thing that the wise driller wants to save.

Mud fluids have for years been used as a carrying medium to remove rotary drilling chips or cuttings from the bottom of the hole and bring them to the surface. These mud fluids have throughout the years served the driller well. At the same time they have been in a good many cases a source of annoyance almost to the point of exasperation. In more recent years where deeper drilling has been undertaken, through geological formations of a character which did not lend themselves to the making of a suitable mud fluid by simply mixing the material removed by drilling with the rotary water, it has come to represent an expense item of material size.

Clean mud fluid, or clean mud, to the rotary operator means, for one thing, a mud that is free from coarse cuttings or sand. These foreign particles when circulated through the mud system, work havoc with pump liners and valves, may plug up the drill bit, and if they are present in any considerable quantity, may stick the tools in the hole if circulation is through any cause interrupted.

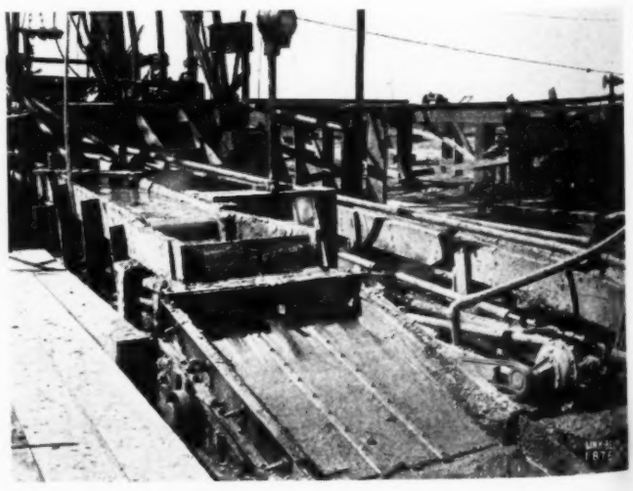
In addition, when gas is present the mud becomes "gas cut", and unless the gas is removed from the mud before it is re-circulated, the normal weight per gallon is reduced, and it becomes too light to be of further use, and must be thrown away or doctored up.

Again, on many locations available native muds do not make a mud fluid that is equal to the requirements or conditions under which the drilling operation is being carried on. In these cases other materials in the form of imported clays or compounds must be added to produce a mud fluid of desired weight and general characteristics. These materials add expense, and it therefore becomes imperative that the mud be cleaned, instead of being discarded and thrown away. In other words, separate the good from the bad—throw the bad away and use the good, keeping the good in desirable condition by a continuous cleaning process.

Link-Belt Company has recently introduced into the oil fields a mud cleaning device that is new to the oil industry but old to many other industries. It is a self-contained vibrating screen that has been in successful use on a commercial basis on many other materials for five or more years. This seems to be a case of teaching an old dog new tricks. In other words, an old and tried machine was given the new job of cleaning rotary mud, and it does it well. It removes the rough foreign particles down to a size that will be retained on a thirty to forty mesh screen, and "degasses" the mud during the operation.

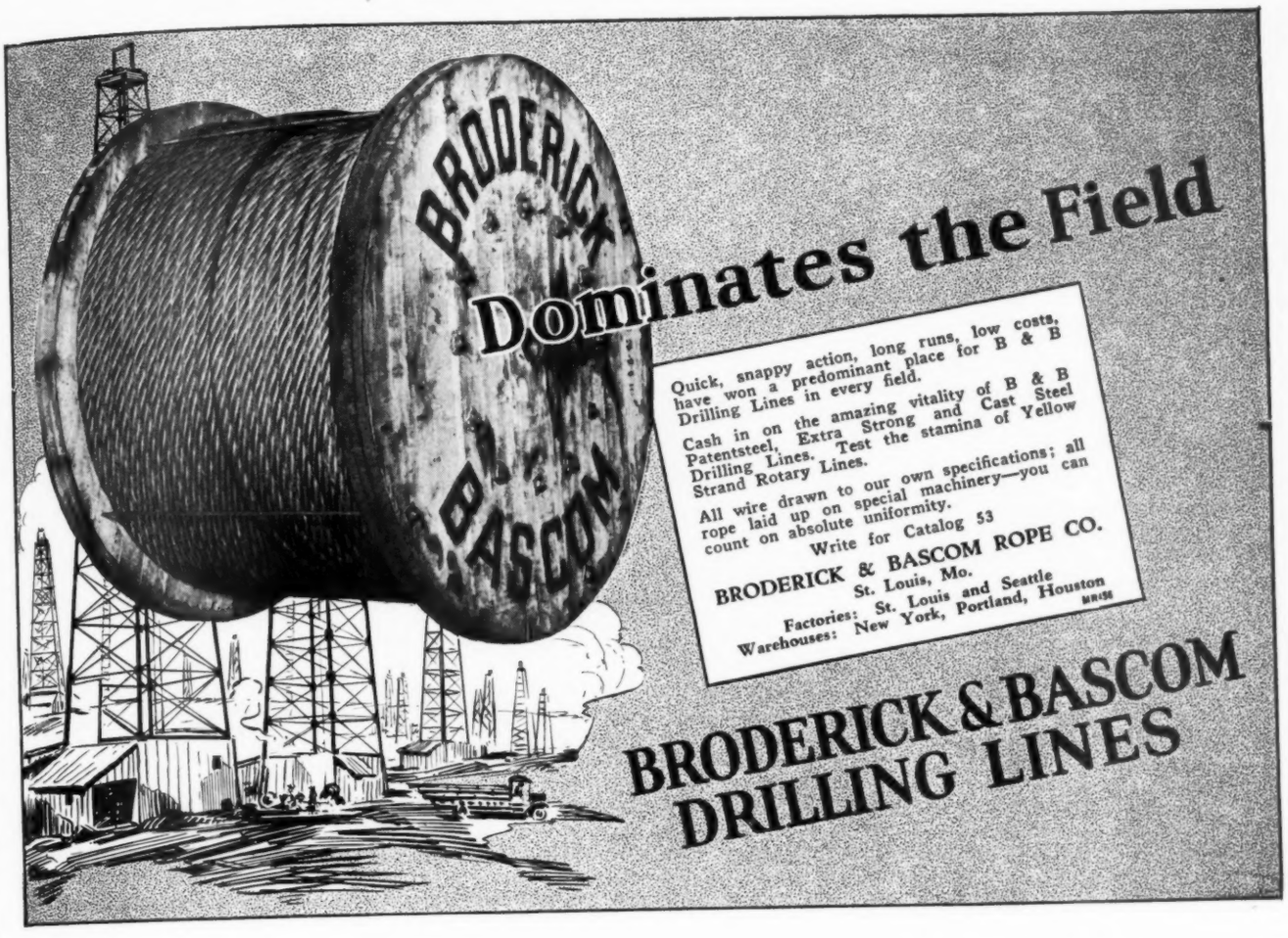
The mechanism is extremely simple, both in construction and operation. It consists of a suitable screen deck carried in a suitable screen box, which screen box is in turn carried on four heavy springs of the flat clock spring type. The carrying springs are carried in spring boxes mounted on a steel sub-frame. A high frequency vibrating motion is imparted to the screen box and to the screen deck by means of a rotating shaft mounted directly underneath and attached to the screen box. The shaft is carried in dirt-sealed anti-friction bearings. Mounted on the rotary shaft are out-of-balance pulleys, which pulleys are so designed as to permit the varying of the intensity of the vibration by the use of selected sizes of counterweights that are furnished with the machine. The vibrator shaft is driven at about 1800 revolutions per minute through a multiple V-belt by either an electric motor or steam turbine.

The machine is set up in an inclined position at a convenient place outside of the derrick, and in such a manner that the mud fluid being discharged from the hole is delivered along the top edge of the screen. The good fluid passes through this screen into a trench through which it passes to the pump sump. The coarse rejected cuttings fall off the lower end of the screen into a reject pit, and the gas, if any is present, escapes into the air during the screening operation.



General view of the Amerada layout—the cuttings pit being in the foreground.

*Vice-President Link-Belt Co.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Newly completed Empire well and its hook-up.

Development of Water Supply Important

WATER, usually thought of as a very undesirable fluid by oil men, is of real importance in the development of any oil production. The development of an adequate water supply in many areas of the country occupies nearly as much attention as that devoted to the securing of crude oil production.

The larger the field, and the more activity, the greater is the demand for water. Few people have stopped, perhaps, to realize the tremendous amount of water it takes to develop a large pool. An amount considerably over one hundred million gallons of water has been consumed at Oklahoma City already for the drilling of completed wells only, and a large additional gallonage has been used in the transportation of crude and in many other ways, while each day this huge sum is being increased.

The average drilling well at Oklahoma City consumes an average of 2,000 gallons of water per day, the amount varying according to the depth of the well. The first 30 days the average consumption is somewhere around 2,500 gallons daily to the well, with this figure declining to about 1,500 gallons for the last 30 days, with 2,000 gallons used for the intervening 30 days.

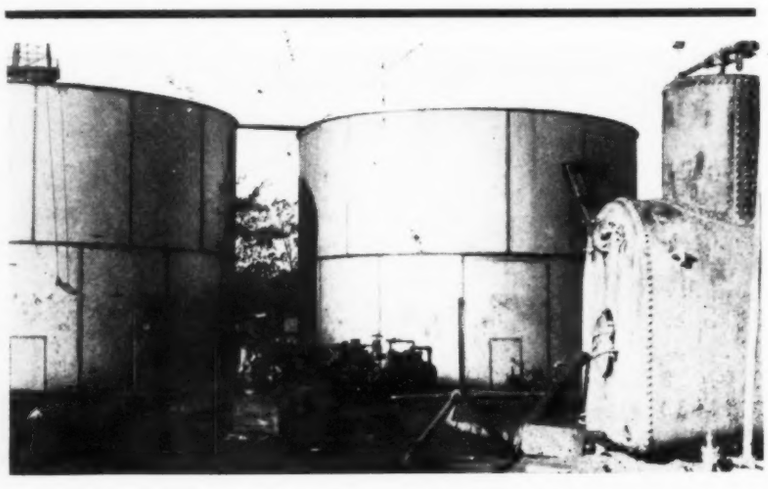
The principal use for water in the field is for the boilers, where it forms the steam power for running the rigs. Another very important use of water is for the mixing of rotary drilling mud. It is also used in large quantities at refineries, pipe line stations, pump stations, natural gasoline plants and in many other places.

When possible, water is obtained from creeks, rivers and ponds, but in many cases this volume is not sufficient to carry on all the operations, and, then, other sources of water supply must be developed — in the form of water wells.

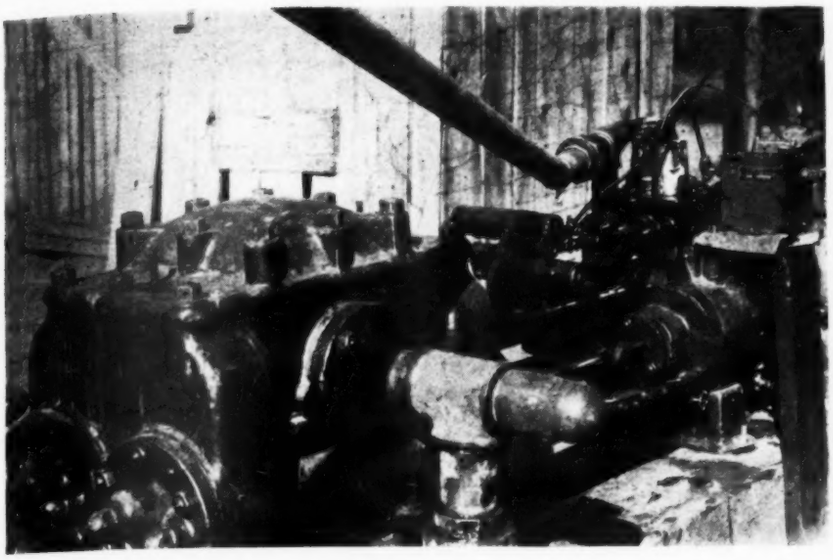
So many people have the idea that water is easy to secure and that it is only necessary to sink a hole to a given depth to encounter water production, but this is far from true. Water lies under the ground in veins or stratums, and not in pools like oil. This sometimes makes it doubly hard to locate. After once locating a water pay it is occasionally difficult to trace because of its twisting course. An example of this was shown in a test for water at Oklahoma City, where a distance of six feet was the difference between a water well and a dry hole.

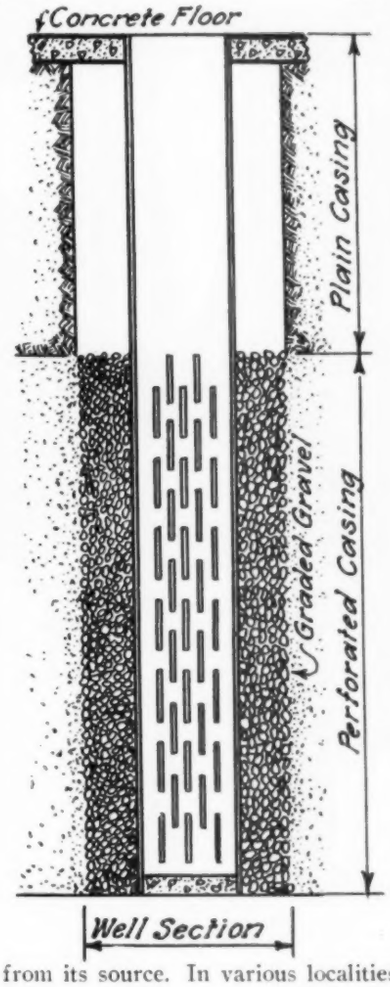
The topography of the surface is probably the first condition to be considered in drilling or digging for water. Oftentimes surface conditions indicate that a certain area was once an old river bed, a good indication of water. The thickness of the sand, as in oil production, is quite an important item in the life and production of a water well.

The depth of the producing horizon is another important factor. The shallower the depth at which an



A hook-up at a well belonging to John Mabee, drilling contractor.





Above—A pump being used for transporting water. At right — Cross-Section drawing of a gravel-treated well. Below—An uncovered well of T. B. Slick Co.

abundant supply is available, naturally the more economical the well in both drilling or digging and in the lifting cost.

Each locality has its own particular conditions to be dealt with. In some localities both drilled hole or open-type wells are suitable.

In the Mid-Continent today, water drilling contractors are being depended upon to a larger extent by the oil companies for the developing of water sources. A number of these are operating on a highly scientific scale. Drilling is seldom carried on in the haphazard method formerly employed, and in which a great deal of money has been lost every year by improper making of wells. It is becoming a practice to first test a location before digging the well. These water contractors have made it their job to study the conditions and put the well down in the most advantageous location in each case.

Operators of the Oklahoma City field had several sources of water available through the city mains and the Canadian River that runs through the north part of the field and both are being used by various companies and drilling contractors. The supply, however, proved inefficient for the operations, and now many of the companies are depending upon water wells.

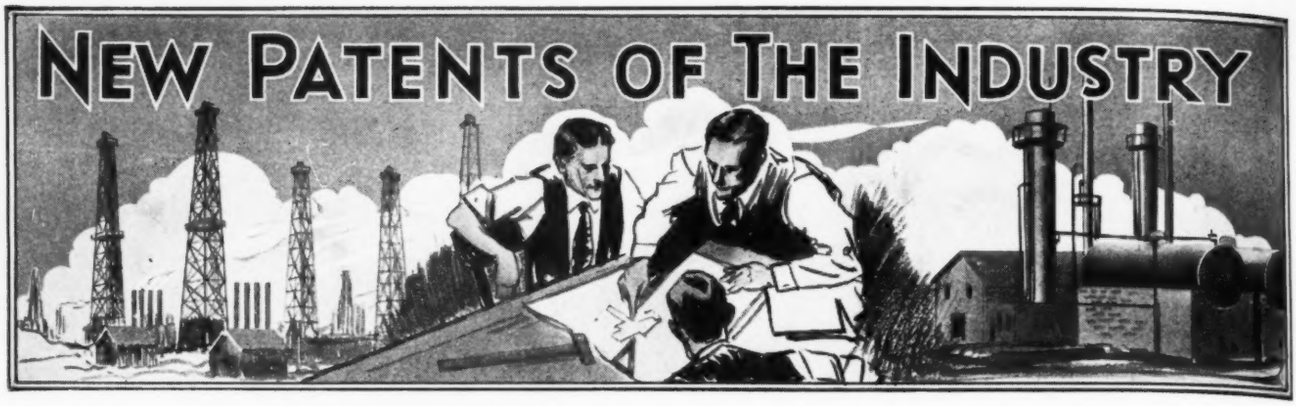
The largest water plant in the field is that of the Indian Territory Illuminating Oil Company. At first this company depended upon the river for all its water and constructed a water plant along the banks, but during the drouth of the summer months another source was necessary.

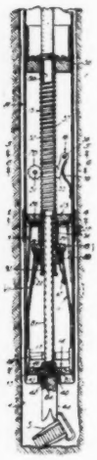
After considerable testing and coring, by the Shuler Company, water contractors and water supply developers, the company now has five water wells, from 33 to 50 feet deep, having a potential output of approximately 100,000 gallons per day, which is more than enough to take care of the company operations at this time.

These wells are all electrically operated. The water is pumped from the wells to stock tanks, and pumped to the company's big water plant on the river.

All of these wells are gravel treated, as are a number of others in the field. Clam shells, supported by small steel derricks, were used in digging the wells. The hole is cased off with huge casing, the smallest being an eighteen-inch string that penetrates the producing horizon. It is perforated for the entrance of water. Behind this string of casing the hole is filled with gravel, which keeps the hole free and clean.

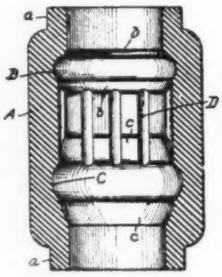
While the Indian Territory Illuminating Oil Company depends upon electric current for the moving of its water to the source of need, several other companies have pumps operated by steam power. Water in many of the cases is piped for many miles from its source. In various localities of the country it is necessary to treat the water before using. It must not contain foreign matter that would injure the machinery through which it passes. In other parts of the country the water is of sufficient quality as to pass inspection and need no treatment.





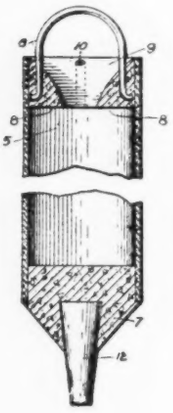
1,775,340. GRAB. Joseph G. Fitzpatrick, Anaheim, Calif. Filed May 6, 1929. Serial No. 360,671. 16 Claims. (Cl. 294—115.)

1. A tool of the character described including a tubular body, a stem shiftably carried in the body, spaced arms pivotally connected with the stem to be shiftable therewith and to have free ends normally within the body, means for operating the stem to project the arms from the body, and means for operating the free ends of the arms toward each other when projected from the body.



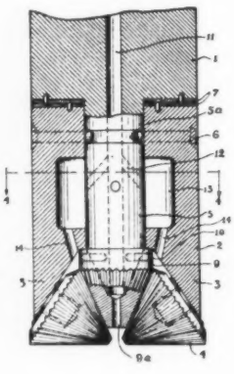
1,775,403. SWAB RUBBER. Lorne Maclean McLeod, Tulsa, Okla. Filed Oct. 15, 1928. Serial No. 312,673. 5 Claims. (Cl. 74—109.)

1. A swab rubber comprising a body having an elongated bore enlarged at spaced points in its length to form expansible chambers, the expansible portions being connected by a plurality of channels.



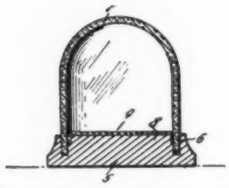
1,775,271. NITROGLYCERIN SHELL. Warren F. Bleecker, Boulder, Colo., assignor, by mesne assignments to William J. Cheley, Tulsa, Okla. Filed March 23, 1926. Serial No. 96,783. 9 Claims. (Cl. 102—4.)

9. Oil well torpedo casing comprising as its explosive container a tube of fibrous material impregnated with material brittle under the shock of detonating high explosive.



1,778,966. ROLLER BIT. John C. Stokes, Houston, Tex., assignor to Reed Roller Bit Company, Houston, Tex., a Corporation of Texas. Filed Sept. 6, 1927. Serial No. 217,675. 8 Claims. (Cl. 255—71.)

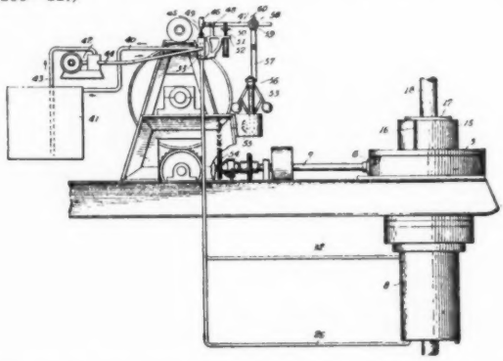
1. In a drill, a substantially conical roller cutter having longitudinal cutting teeth and a substantially conical support, said support being rotatable with respect to said cutter and having teeth meshing with the cutting teeth of said cutter.



1,781,983. DICE BOX. Edwin W. Koch, Tremont, Ill. Filed Jan. 14, 1930. Serial No. 420,727. 1 Claim. (Cl. 273—145.)

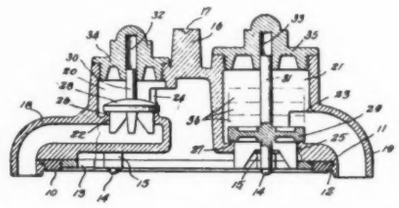
A dice box comprising a receptacle of transparent material closed at its top and open at its bottom, a supporting base for said receptacle normally closing the opened bottom of the receptacle, said bottom being of substantially relatively flat disk like formation and having on the top face thereof an annular groove inwardly of the peripheral edge thereof for receiving the lower edge of said receptacle, and a disc of relatively soft material covering the top face of said base and having its peripheral edge arranged within the groove, said disc presenting a sound deadening surface for the base.

1,781,706. WELL-DRILLING APPARATUS. Waldo Sheldon, South Norwalk, Conn. Filed May 5, 1926. Serial No. 106,850. 17 Claims. (Cl. 255—22.)



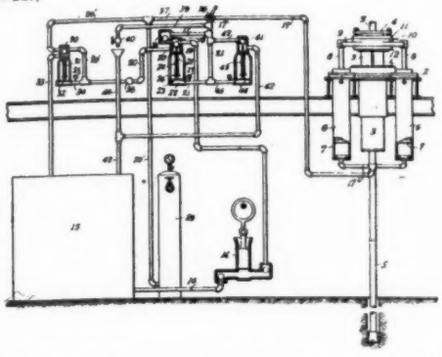
1. In well drilling apparatus, a table for rotating the drill hydraulic power mechanism for controlling feed of the drill, a control valve for said hydraulic power mechanism and a speed governor associated with the table and adapted to exercise control over said valve.

1,781,722. THIEF-HOLE COVER. Conrad Ehret, Oklahoma City, Okla. Filed Oct. 28, 1929. Serial No. 403,028. 7 Claims. (Cl. 220—85.)



2. A thief-hole cover for tanks comprising a base adapted to be secured upon a tank about an opening therein, a cover for the upper end of said base and formed with ports, valve houses each independent of the other and each having an inner opening and an outer opening, conduits leading from the outer openings of said valve houses and having downturned outer ends, and check valves in said valve houses, the valve in one house opening inwardly and the valve in the other house opening outwardly.

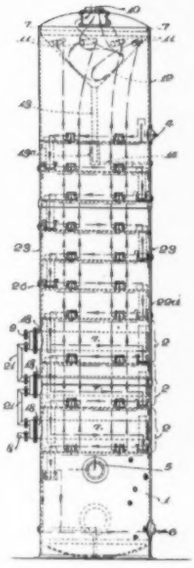
1,781,707. WELL-DRILLING APPARATUS. WALDO SHELDON, South Norwalk, Conn. Filed May 16, 1927. Serial No. 191,795. 14 Claims. (Cl. 255—22.)

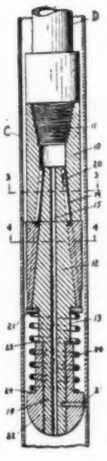


3. In well drilling apparatus, a hydraulic cylinder, a piston therein operative in one stroke to govern the drill feed, a pressure storing reserve tank for containing a reserve supply of fluid for effecting rapid return stroke of the piston, a pump for supplying actuating fluid to the cylinder and reserve tank, connections from the pump to the cylinder and reserve tank and means automatically governed by the pressure in the cylinder and reserve tank for controlling the flow from the pump to the cylinder and reserve tank.

1,759,750. GASOLINE METHOD. M. H. KOTZEBUE, Tulsa, Okla. The method of absorbing a gas in an absorption liquid which comprises repeatedly bubbling the gas through a layer of said liquid and cooling the liquid between each bubbling step.

Apparatus of the character described comprising adjoining bubble trays for containing an absorption liquid, means associated with each tray permitting passage of a gas both through the trays and the liquid carried thereby, a temperature control element located intermediately of the trays having means at one end affording communication with one end with an opening in one of the trays for the influx of the liquid and means at the other end for the efflux of the liquid to the succeeding tray, and means associated with said last means establishing a liquid seal.

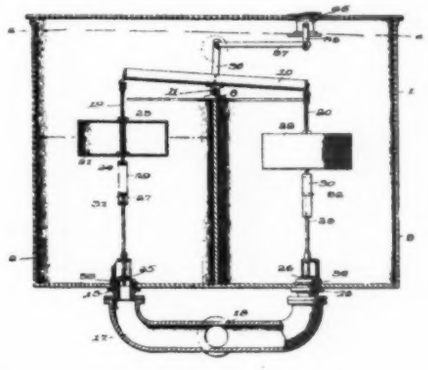




1,779,123. HYDRAULIC CASING SPEAR. PAUL G. GATES, Gardena, Calif. Filed Aug. 5, 1929. Serial No. 383,445. 8 Claims. (Cl. 294—96.)

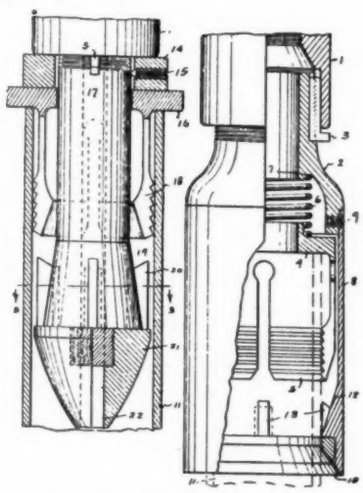
1. A hydraulic casing spear comprising a body having inclined guides, slips movable upon the guides adapted to assume contracted or expanded positions thereon, and hydraulically operable means for moving each of the slips independently of the others.

1,781,744. FLUID METER. CHARLES H. BERGQUIST and RICHARD BATTLE, Okmulgee, Okla. Filed July 9, 1926. Serial No. 121,415. 3 Claims. (Cl. 73—28.)



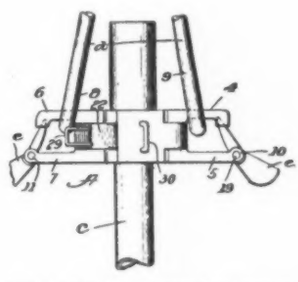
1. A gravity meter for liquids including pivotally mounted oscillatory means, a nozzle discharging liquid into said means adjacent its pivotal axis, said nozzle extending in a horizontal direction and being flared outwardly for distributing liquid at a distance on both sides of said pivotal axis to increase the inertia of the liquid in its descent toward the lower end of said means, vessels into which said receiving means alternately discharges, means responsive to a definite depth of liquid in said vessel for oscillating said first mentioned means, discharge valves for said vessels, and means for alternately actuating said valves, said last mentioned means moving independently of said valve during the initial part of each oscillatory movement, whereby to gather inertia and to deliver a hammer blow to said valves for opening the latter.

1,781,918. PIPE-PULLING MACHINE. CHARLES R. EDWARDS, Houston, Tex. Original application filed Feb. 20, 1923. Serial No. 620,240. Divided and this application filed Sept. 6, 1927. Serial No. 217,731. 37 Claims. (Cl. 294—96.)



1. A releasable pipe-puller including a member having a tapered slip seat, a slip support, a slip carried by said support and adapted to engage the pipe to be pulled and having a tapered seat, said member being movable into one position relative to said slip to bring said seats into co-operating relation whereby the slip is forced into secure engagement with the pipe, said member being movable into another position to carry said seats out of co-operating relation to permit said slip to release said secure engagement with said pipe.

1,781,922. WELL ELEVATOR. JOHN GRANT, Los Angeles, Cal., assignor, by mesne assignments, to Byron Jackson Co., West Berkeley, Cal., a Corporation of Delaware. Filed Jan. 11, 1923. Serial No. 611,978. Renewed July 17, 1926. 4 Claims. (Cl. 294—90.)



1. A device of the character disclosed including suspension means, a member adapted to be applied to work and provided with spaced arms adapted to receive said suspension means; in combination with movably mounted means normally closing the space between said arms and adapted to move to open said space upon engagement by said retaining means with an object on the movement of said device in one direction; said last named means comprising a finger mounted upon one of said arms and provided with a projection for causing movement of the finger; further means being provided for releasably locking said finger in one position.

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